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NORTH AMERICA IN THE ICE PERIOD.

By JOHN S. NEWBERRY,

PROFESSOR OF GEOLOGY AND PALEONTOLOGY IN COLUMBIA COLLEGE.

ALTHOUGH the glaciated area on our continent has been as yet but partially explored, abundant proof has been gained, as it seems to me, of the truth of the following propositions, viz.:

1. That glaciers once covered most of the elevated portions of the mountain-belts in the West as far south as the thirty-sixth parallel, and all the eastern half of the continent to the fortieth parallel of latitude.

2. That the ancient glaciers which occupied the area described were not produced by local causes, but were the exponents of a general climatic condition.

3. That they could not have been the effect of a warm climate and an abundant precipitation of moisture, but were the results of a general depression of temperature, and therefore afford proof of the truth of what is called the glacial theory.

The facts and arguments which sustain these propositions may be briefly summarized as follows:

The glaciation of the Sierra Nevada is general and very striking. It has been studied by Whitney, King, Brewer, Le Conte, and others, including the writer, who have given abundant proof that all the highest portions of the range were once covered with snow-fields, and that glaciers flowed from these down the valleys on either side. Mount Shasta once bore many great glaciers, of which miniature representatives still remain; the Cascade Mountains exhibit, perhaps, the most impressive record of ice-action known; all the higher portions of the range are planed and furrowed by glaciers which descended into the valley of the Des Chutes on the east, and the Willamette on the west, as shown by my observations in 1855, at least twenty-five hun-

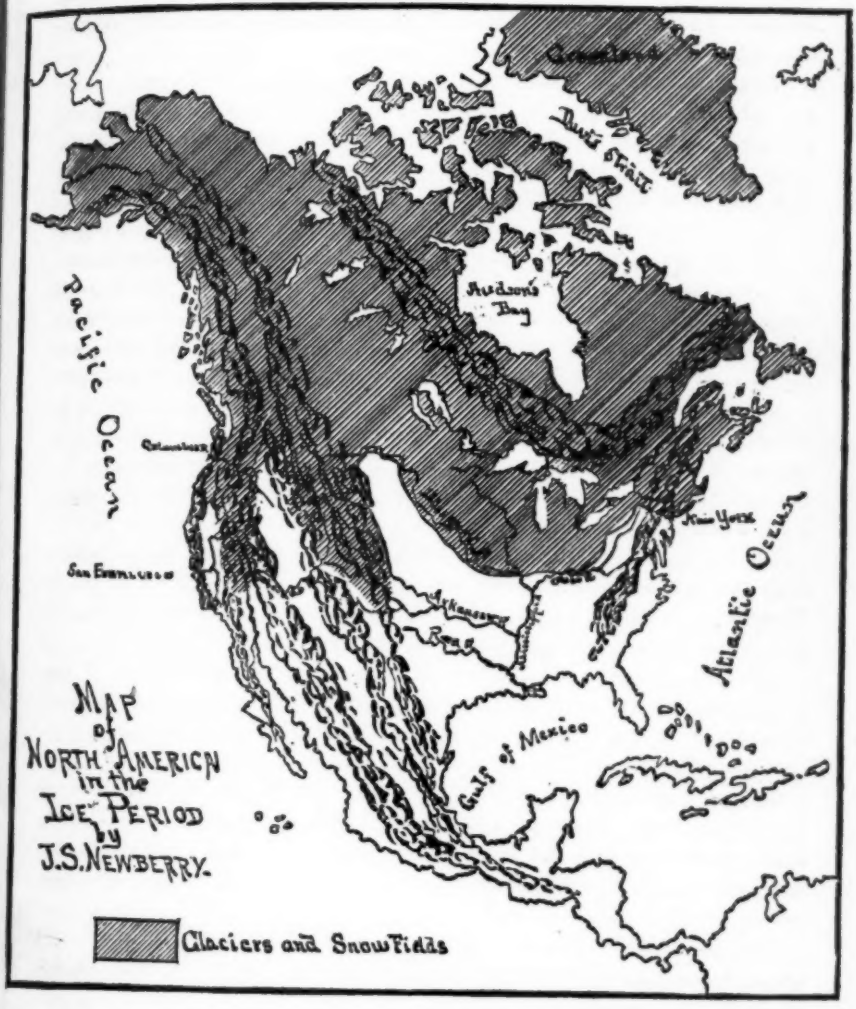
dred feet below the present snow-line. Mount Rainier still carries a dozen glaciers of considerable size, and all the country is glaciated about this and the other snow-peaks of Washington Territory, Mount St. Helen's, Mount Baker, Mount Adams, Mount Olympus, etc., around Puget's Sound, and on Vancouver's Island. In British Columbia, as shown by George M. Dawson, Dr. Hector, James Richardson, and others, the signs of ancient glaciation are conspicuous in all the high country explored. Along the coast farther north the ancient glaciers have left their marks in all the fiords, and those of the present day descend lower and lower until in Alaska they reach the sea-level.

The valleys of the Wahsatch range were once filled with masses of ice as far south as Central Utah. A type of these, though not the largest, was Little Cottonwood glacier, of which the record has been carefully studied by the writer. It formed in a *cirque* at Alta ten to eleven thousand feet above the sea, where its bed is everywhere conspicuously glaciated. It had a length of about ten miles; its thickness, as shown by the line of granitic blocks, left along its sides, was five hundred feet or more, and its lower end protruded into the Salt Lake Valley at a level not greater than fifty-five hundred feet above the ocean. The glaciation of the Uintah Mountains has been graphically described by King, who says that all the higher portions of the range were once covered with a continuous sheet of snow and ice, and that glaciers descended through all the important valleys; also that the ancient glaciers of the Uintahs occupied a greater area than all those now existing in the Alps.

In the Rocky Mountain belt the signs of ancient glaciers abound from the northern part of New Mexico through Colorado and along the great divide in Wyoming, Montana, and Idaho. In the valley of the Arkansas, particularly about Leadville, in the Parks, on Clear Creek, in the valley of the Rio Grande, *roches moutonnées*, lateral and terminal moraines, embankment-lakes, etc., all the work of glaciers, have been observed by thousands of travelers. Here the mountain-belt is very broad and high, is now the great condenser from which radiate all the most important streams of the West, and in winter is covered with a heavy sheet of snow. In ancient times it played a similar *rôle*, only that the snows of winter did not melt as now in summer, but accumulated from year to year until they produced great glaciers. In Wyoming the mountains are narrower and lower, and the glacial signs are less conspicuous; but toward the British line, where the ranges multiply and the summits are higher, the records of glaciation are everywhere apparent.

To summarize the description of the glacial phenomena of this Western region, it may be said that, over all the mountain-ranges north of the limit before given, the traces of ancient glaciation are alike in character and apparently of the same date, and are evidently the effects of general and not local causes.

In the country east of the Mississippi the evidence of ancient glaciation is even more wide-spread and impressive than in the far West. The surface-rocks of Canada, New England, New York, and the greater part of Ohio, Indiana, Illinois, and Wisconsin, bear marks of ice-action, and are generally covered with a sheet of drift material which has been carried from the north southward, often many hundred miles. This



glaciated and drift-covered area extends from Maine and Massachusetts in a belt parallel with the arch of the Canadian highlands five hundred miles wide and more than two thousand miles long. Its extension northward from the head-waters of the Mississippi has not been traced farther than Lake Winnipeg, where it was studied by

Hind; but there are good reasons for believing that it reaches northward to the Arctic Ocean, and that the great lakes of the north, like those of the St. Lawrence chain, Superior, Huron, Michigan, etc., are pre-glacial river-valleys scooped out and modified by ice.*

From the facts already gathered, it is a justifiable inference that fully half the Continent of North America and nearly all north of the fortieth parallel was at one time covered with ice or perpetual snow, and, so far as we can now judge, the glaciation of all the North American localities enumerated was synchronous.

Some writers have attempted to prove that a large part of the glacial phenomena described above is really the work of icebergs and shore-ice, and one of the consequences of a great continental subsidence; but no man who has studied the inscriptions made by glaciers will hold to this theory when he has traversed much of the glaciated areas east or west of the Mississippi. To all the mountainous region of the West it is evident that the iceberg theory is inapplicable, and, when the enormous glaciers of the West are conceded, it is difficult to see why they should be denied to the East. Since, however, the iceberg theory is insisted upon for this section, it may be well enough to say that it is demonstrated untrue by four unanswerable arguments:

1. The inequalities of level in the fancied water-line formed by the margin of the drift area are irreconcilable. Mount Washington, Mount Marcy, Mount Mansfield, must have been totally submerged—because their tops are worn and striated—while the shore-line was at New York at the sea-level, in Pennsylvania twenty-one hundred feet, and at Cincinnati three hundred feet higher. South of the drift-line, high lands and low were alike beyond the reach of the flood, while in Wisconsin it spared a special district not above the general level, and all around it the rocks are scored and strewed with *débris*.

2. The direction of the ice-scratches and the derivation of the bowlders would require the submergence of all the northern portion of the continent, so that icebergs (*which had no land to start from, and therefore could not have existed*) could float southward over all the Canadian highlands; and the local variations of direction (southwest by south, in the basin of Lake Erie, south in that of Lake Huron, south-southwest in Lake Michigan, southwest in Lake Superior, and southeast in New England) show an incomprehensible tangle of ocean-currents.

3. The complete absence of marine shells from the great drift area of the interior, while they are abundant in the Champlain and bowlder clays on the coast, is incompatible with this theory.

4. The inscription left by the eroding agent is altogether *sui generis*, and characteristic of glacial action, and not at all that which could be effected by dragging masses of ice over the sea-bottom. This in itself is a conclusive refutation of the theory. The record made by a glacier

* See position of northern lakes on map.

is unmistakable, and no one who has not learned the language in which it is written is warranted in taking part in the discussion; but he who has done so will find graven on the rocks of the Alps, the hills of New England, the basins of the Great Lakes, and the mountains of Colorado and Oregon, an inscription which is everywhere the same, which can have but one meaning, and bears a signature that can not be counterfeited.

While it is hopeless to expect that all men will agree upon this—or any other—subject, I think I am justified in saying that the facts which have been stated, and others of like import, constitute an indisputable record, not necessarily of the former existence of a great ice-cap over all the northern regions, but of the simultaneous prevalence of sheets of land-ice, i. e., glaciers, over great areas of our continent; and that these glaciers, forever in motion, holding imbedded in their substance sand, gravel, and bowlders, pressed against the underlying rock by their enormous weight (probably averaging fifty thousand pounds to the square foot),* became powerful agents of erosion; general and uniform when they were broad, narrow and special when they were local. This is the reading of the facts now given by those who are best qualified to judge of the import of the phenomena in the Old World and in the New. Already the belief in an ice period and ancient glaciers is general—hereafter, with more complete knowledge of the subject, it must become universal.

Accepting the facts cited above as demonstrating the truth of the glacial hypothesis, and as proving beyond cavil the reality of an ice period, we now pass to consider the proximate and remote causes of the distinctive phenomena of this remarkable chapter in geological history.

With characteristic conservatism Lyell endeavored to account for the prevalence of glaciers over the northern hemisphere by supposing them to be due to a peculiar arrangement of land and sea; broad and elevated areas of land in the Arctic regions, low and narrow land surfaces in the tropics. I have elsewhere† discussed this question at some length, and have shown that this theory is untenable, because: First, during the Tertiary age the land was high at the north, no marine Tertiary deposits being found there; Asia, Europe, and America were then connected by land, and the tropical currents were excluded from the Arctic Ocean,‡ but in that age a warm climate

* Fifty-four thousand eight hundred and ten pounds for one thousand feet in thickness; in some cases (around Mount Washington), probably two hundred and fifty thousand pounds.

† "Popular Science Monthly," July, 1876.

‡ At least through the channels of the North Pacific or North Atlantic. It has been suggested that in the Tertiary ages a communication existed between the Mediterranean and the Arctic Ocean by way of the Caspian Sea, Sea of Azov, etc.; but if there was an open channel across Western Asia at that time—which has not been proved—it could hardly have been broad and deep enough to permit a flow through it *both ways* (for no other channel is known) of sufficient volume to modify the climate of the Arctic regions.

prevailed over all the Arctic regions. At the same time the tropical lands were locally if not generally lower than now, since in the West Indies and on the borders of the Gulf of Mexico are broad sheets of marine Tertiary; Second, because all evidence is wanting of high northern lands during the ice period; and, at least during a portion of the time when an arctic temperature prevailed from New York northward, the sea stood much higher than now, receiving and precipitating the Champlain clays—the fine flour ground by the land glaciers—and burying in them arctic shells.*

In the article referred to I have shown that no terrestrial causes yet suggested are adequate to produce an ice period, and that we are compelled to look to some cosmical cause for an explanation of its occurrence.

Recently a voluminous and elaborate review of the subject has been published by Professor J. D. Whitney, with the title of "Later Climatic Changes," the object of which is to prove that there has never been an ice period, properly speaking. To establish this, it is claimed that ice has little or no eroding power; and the few ancient glaciers, of which the evidence can not be ignored or sophisticated, are considered as the products of local causes. Following Lècoq and others, Professor Whitney claims that since snow and ice are forms of moisture evaporated elsewhere by heat, the extension of glaciers at any time or place is simply an effect of increased evaporation—of heat and not cold—and hence if there ever was an ice period, meaning a time when glaciers were more widespread than now, it must have been a warmer period than the present; forgetting, apparently, that increased congelation is the only necessary feature in the increase of glaciers, for, without this, increased evaporation and precipitation would be inoperative. Only a few of many facts need be cited to show that this theory is untenable: 1. Glaciers are now confined to altitudes and latitudes where the temperature is low—Alpine summits and the Arctic and Antarctic Continents. To extend the reach of the glaciers now existing, and to reproduce them where they existed formerly but are now absent, it would be only necessary to widen and intensify the conditions upon which their existence depends, viz., lower the temperature and cause the present precipitation to be more generally fixed in ice and snow. A single example will be sufficient to prove the truth of this statement. On the Cascade Mountains in Oregon we find a copious precipitation of rain and snow, but no ice where great glaciers formerly existed. The snow-fall is so heavy that the snow-line is brought down to an altitude of seven thousand feet above the ocean, and there the temperature is high enough to permit the vigorous

* The Champlain clays about New York are near the present sea-level. At Croton Point they are 100 feet higher; at Albany, 200 feet; on Lake Champlain, 350 feet; at Montreal, 500 feet; on Labrador, 800 feet; on Davis Strait, 1,000 feet; and at Polaris Bay, 1,600 feet above the ocean.

growth of trees and smaller plants. The fir-forests here meet the snow-banks in actual mechanical conflict, and the front ranks of trees, though of good size, are weighed down by the snow and grow prone and interlaced upon the ground. The snow-fields rise three thousand to four thousand feet above the snow-line, and there are miniature glaciers at the heads of the valleys—representatives of the great glaciers that once filled these valleys to their mouths. The precipitation remains, the snow-fall remains, but the glaciers are gone. Here we have just the conditions most favorable to the formation of glaciers according to the theory of those who regard glaciers as *thermal phenomena*, but no glaciers—*because of the high annual temperature.* With an increase of the average annual temperature, even with increased evaporation and precipitation, it is evident that no glaciers would form ; but with a *depression* of temperature which should cause the rain-bearing winds from the Pacific to do all the year what they now do only in winter ; viz., heap up snow on the highlands ; and some of this snow-fall should accumulate year after year, the mountain-slopes and draining valleys would soon be occupied by glaciers, as they were in former times. So if winter conditions could be made permanent on the great water-shed of the Canadian highlands, and the water of the St. Lawrence, the Mississippi and Red Rivers were retained in the form of snow and ice, glaciers would fill again the lake-basins, override the highest summits, and cover with an ice-sheet all the old glaciated areas.

Even if the evaporation from adjacent seas were somewhat diminished by the cold, that would not change the result, though it would prolong the time. The evaporation from the ice-cold oceans in the regions surrounding the north and south poles is now sufficient to produce continental glaciers in Greenland and on the Antarctic Continent, and it requires no argument to show that like conditions would produce like results in what is now the temperate zone.

On the theory that increased evaporation and precipitation would cause an extension of glaciers, and as an illustration of their local origin, it has been suggested that the water with which the dry regions of our Western Territories were once abundantly supplied produced the glaciers of which we find traces on the adjacent mountains, and the exhaustion of the water caused the disappearance of the glaciers. We shall see, however, that this is a speculation which is as yet sustained by no proof. It is well known to all geologists that the interior of the North American Continent has been occupied by a succession of great fresh-water lakes, extending in time from the early Eocene to and through the Quaternary. The history of these lakes has been admirably worked out by King, Gilbert, and Russell. Those of the Tertiary were numerous and broad, providing ample evaporating surfaces, but so far as we know they contributed nothing to the formation of glaciers—which could not have existed, indeed, under the warm sun

of the Tertiary ages, except on mountains higher than any the continent now bears. In the Tertiary the climate was sub-tropical over all the area of the United States south of the British line, as is shown by the fact that palms and cinnamon-trees grew as far north as Vancouver's Island and the falls of the Missouri.

The relations which the great Quaternary lakes, Bonneville, La Hontan, etc., bore to the former glaciation of the adjacent mountains is an interesting subject of inquiry. As I have mentioned, it has been suggested that it is the relation of cause and effect, but this is supported by no proof, and opposed by strong circumstantial evidence. The lakes and the glaciers may have been synchronous, and, to some extent, co-operative phenomena; but the relationship was rather fraternal than filial, as they had probably a common parentage.

The cause of the former wide spread of water-surfaces in the undrained portions of the Great Basin was either more copious precipitation or less rapid evaporation than at present. It is well known that the supply of moisture of this region is derived from the rain-bearing winds which blow steadily on to the land from the Pacific, and "the testimony of the rocks" is conclusive to the effect that there has been no change in the outline or elevation of the land, or the relations of land to sea since the Tertiary age, which could have materially increased or diminished the precipitation.

So in regard to the topography of the interior. Since the end of the Tertiary it has remained essentially the same. The hydrographical basins have been filled and emptied, but the old beach-lines which mark their sides prove that the country has remained substantially undisturbed. It is apparent, therefore, that the causes of any variation in the amount of precipitated or accumulated moisture must be climatic and not topographical. King, Gilbert, and Russell have shown that there have been several alternations of wet and dry climate in the Great Basin, and they are substantially in agreement that there have been two wet and two dry periods, of which the last is the present.

It would seem easy to determine by observation the relationship between the lakes and glaciers of that region, since some of the glaciers descended far below the highest water-level, as was the case with the Little Cottonwood glacier, to which reference has already been made, but the actual contact of the glaciated surface and the lake sediments is there covered and concealed by modern *débris*. The observations made elsewhere by Gilbert and Russell will, when published, probably demonstrate that which can now only be conjectured. We can confidently predict, however, that it will be found that the same climatic condition which produced the accumulation of water in the lake-basins also caused the accumulation of congealed water on the highlands. A greatly increased rainfall might produce lakes without forming glaciers, but we appeal in vain to the facts or the imagination for a probable cause of an increased oceanic evaporation, with a more abundant

precipitation on the land. Hence we seem driven to the acceptance of the other alternative—diminished evaporation—for the filling of the reservoirs of the Great Basin. And when we search for a cause of diminished evaporation only one presents itself, but that offers an easy and natural solution of the problem. A depression of temperature would certainly reduce evaporation (since the power of air to absorb moisture varies directly with the temperature), and at the same time form lakes in the valleys, and glaciers on the mountains. To prove this, we have only to cite the phenomena presented by summer and winter in the Western Territories. In winter the snow-fall on the highlands is heavy, and the accumulation of moisture in this form is large; the skies are cloudy, and the evaporation is small. In summer the sky is cloudless, the heat intense, evaporation and desiccation rapid. In the spring the snows melt, flood the valleys and form temporary lakes, which in midsummer dry up to *playas*. A climatic change which would perpetuate the conditions of winter and spring would inevitably produce glaciers and lakes, and these would be in the main synchronous; and thus all we find recorded in the past history of this region would be repeated. But to intensify and prolong the summer would not produce either lakes or glaciers.

From the facts which have been enumerated above, it will be seen that from all sides we get evidence confirmatory of the theory that a certain period in the history of this continent was marked by the spread of ice and snow over a very much larger portion of the surface than they now occupy; and that we are fully justified in designating this time as an ice or glacial period; also that this was a period during which, from some extraneous cause, the climate was made colder, and the conditions which now prevail on Alpine summits perpetually, and in winter elsewhere temporarily, were more wide-spread and continuous.

That the Ice period was cold and not warm is also proved by the presence of the remains of an arctic flora and fauna in all regions near the old glaciers; the arctic shells of the Champlain, the arctic plants in the Quaternary clays, the reindeer, the musk-ox, the woolly elephant, and woolly rhinoceros, all tell the same story.

On the preceding pages the Ice period is spoken of as a single geological epoch of the Quaternary age: and so it must be reckoned in any general division of geological time. But the evidence is conclusive that the Ice period was double; that is, there were two maxima of cold separated by a long interval in which the climate was ameliorated, and over large areas which had been for ages occupied by glaciers and snow-fields, the ice and snow were withdrawn, and the surface was covered with vegetation, again to be partially taken possession of by glaciers.

Just how far north the glaciers retreated during the interglacial warm period we do not yet know, but probably not far beyond the Great Lakes; since the vegetation which covered Southern Ohio, dur-

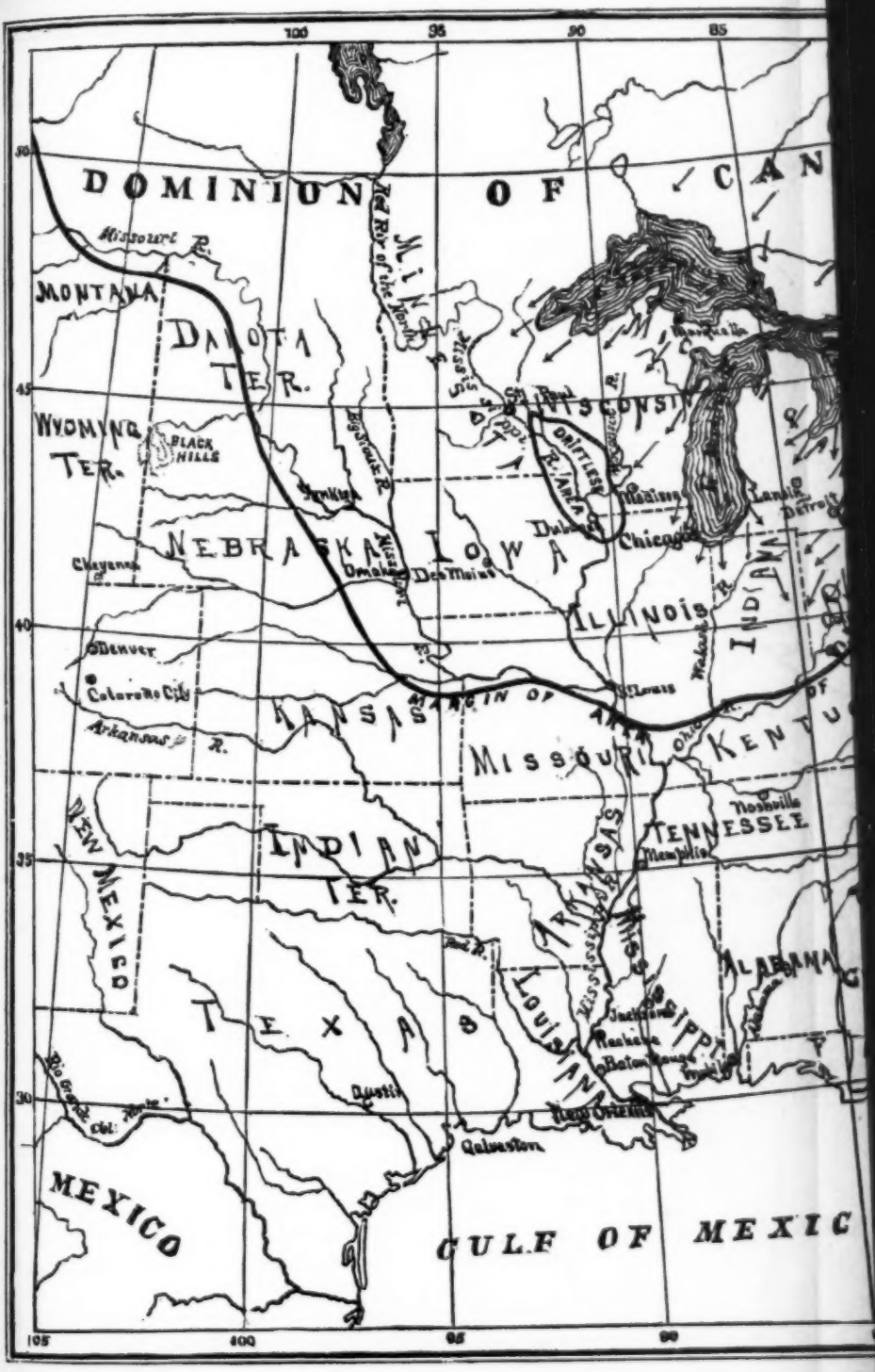
ing the interval represented by peat-beds between the first and second bowlder clays, was that of a cool climate, and the interglacial beds have not been traced beyond Scarboro Heights, on Lake Ontario.*

Facts similar to those from which we have sketched the history of the Ice period in North America, observed in Europe and Asia, afford abundant evidence that the conditions which existed here prevailed over all the northern hemisphere. In South America also similar phenomena have been observed and reported by many geologists. Hence, any explanation offered of the records of the glacial period found here must be comprehensive enough to include the whole great field; and the difficulties which here oppose the acceptance of a theory that is only local in its scope, grow until they become insurmountable. That the conditions which prevailed simultaneously in different parts of the northern hemisphere during the Ice age were synchronous with similar conditions in the southern hemisphere is not proved, nor is it probable that it is susceptible of proof. By many, perhaps most geologists these conditions are supposed to have alternated at the north and south. This much, however, we are justified in asserting, that at an epoch holding the same relative position in geological history north and south of the equator, either simultaneously or alternately, cold climatic conditions prevailed in both hemispheres and left records that are alike in character and import.

An inquiry into the nature of the cosmical influence which we must credit with the phenomena of the Ice period would lead beyond the scope of this paper, and open questions too broad and suggestive to be settled or even adequately discussed in the space at our command. I shall, however, have accomplished the end I had proposed to myself if I have shown—1. That the Ice period was a cold period. 2. That the record of the Ice period on our continent is more complete and impressive than it has been represented to be. 3. That it is the product of general and not of local causes. 4. That these causes were not topographical or even telluric, but extraneous and cosmical.

The question here passes rather into the hands of the astronomer and physicist. The work of the geologist is done when he has shown that the complete solution of the problem does not lie within his domain; that no telluric agency is adequate to produce the phenomena; and that some cosmical cause, such as a variation in the heat radiated by the sun, as suggested by Newcomb, changes in the eccentricity of the earth's orbit, as advocated by Croll, or some other general and all-powerful influence, must be credited with effects as wide-spread and stupendous as those the Ice period has left behind it.

* Although this paper is limited in its scope to a consideration of the glacial phenomena of North America in the Quaternary age, and to certain erroneous notions which are entertained in regard to it, it may not be out of place to say that it is believed by many geologists that there have been several ice periods, and one at least as far back as the Permian epoch.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ORIGIN AND RESULTS OF SUNDAY LEGISLATION.

By Rev. A. H. LEWIS, D. D.

THE times demand a reconsideration of our Sunday laws. They are practically inoperative. There must be some essential reason for this, in the character of the people or in the character of the laws; perhaps both. Either the laws have a false basis, and can not rightly claim public regard, or the people are wickedly indifferent to rightful authority. This is true of the Church as well as the "world." To know the origin of these laws will help to solve the problem.

Sun-worship is the oldest and most wide-spread form of paganism. It reaches back to the prehistoric period. Under various phases it has always been the persistent foe to the worship of Jehovah. It was the prevailing and most corrupting form of idolatry which assailed the Hebrew nation. Its lowest form, Baal-worship, produced the deepest social and moral degradation. As the period of idolatry passed away, sun-worship assumed a less materialistic form, without losing the virulence of its poison. It lay in waiting, like a beast of prey, to corrupt Christianity, as it had already corrupted Judaism. Transferred from the East, and from Egypt, to Greece and Rome, it became popular, and great efforts were made under Heliogabalus and others, in the third and fourth centuries, to exalt it above all other religions. Indeed, Mithraicism came near gaining the field and driving apostolic religion out of the Roman Empire. It did corrupt it to an extent little understood.

Pagan Rome made religion a part of the state. Long before the advent of Christianity, the emperor, as head of the state and therefore of the Church—Pontifex Maximus—was accustomed to legislate upon all religious matters. He had supreme power in this direction. Scores of sacred days were set apart, under the pagan empire, upon which judicial proceedings and certain forms of work were prohibited. It was the settled policy of the empire for the emperor thus to determine concerning *ferial* days. Apostolic Christianity forbade all appeal to the civil law in matters of Christian duty. Christ and his apostles sought only the rights of citizenship at the hand of civil government. When these were refused, they gladly yielded, suffering persecution, unto death, if need be. Christ repeatedly declared, "My kingdom is not of this world." New Testament Christianity could not have instituted such a cultus as that which gave rise to Sunday legislation, the union of church and state, under an emperor or an emperor-pope. "Old Mixon" peach-trees can not bear crab-apples. All civil legislation concerning religious faith and practice, such as obtained in the Roman Empire, was the product of paganism. It was not an offshoot of Christianity, or of the Hebrew theocracy.

The first civil legislation concerning Sunday appears in the edict of Constantine the Great, 321 A. D. Nothing appears in history as demanding the legislation, or as wishing it, except the will of the emperor. He was a well-known devotee of the sun-god, as were his predecessors. His attitude toward Christianity, both before and long after the issuing of the Sunday edict, was the attitude of a shrewd politician; toward his rivals it was that of an unscrupulous, bloody-handed monarch. He gained power by intrigue, deceit, and murder. No accurate historian dares call him a "Christian emperor." Romish tradition and superficial literature have misnamed him the "first Christian emperor." The facts relative to his life and character forbid every such claim. He refused to unite with the Christian church until he lay on his death-bed, in 337 A. D., when he received baptism, hoping thus to make the most of both worlds. The text of his Sunday edict, and the surroundings, all show it to have been purely heathen. The text is as follows:

"Let all judges, and all city people, and all tradesmen, rest upon the *venerable day of the Sun.* But let those dwelling in the country freely and with full liberty attend to the culture of their fields; since it frequently happens that no other day is so fit for the sowing of grain or the planting of vines; hence the favorable time should not be allowed to pass lest the provisions of Heaven be lost.

"Given the 7th of March, Crispus and Constantine being consuls, each for the second time."—("Codex Justin.," lib. iii., tit. 12, l. 3.)

If the foregoing law were associated with Christian laws, the testimony against it would be less damaging. But the following shows that on the next day Constantine issued another edict, which, like the above, is unmixed paganism.

Edict concerning haruspices:

"The august Emperor Constantine to Maximus:

"If any part of the palace or other public works shall be struck by lightning, let the soothsayers, following old usages, inquire into the meaning of the portent, and let their written words, very carefully collected, be reported to our knowledge; and also let the liberty of making use of the custom be accorded to others, provided they abstain from private sacrifices, which are specially prohibited.

"Moreover, that declaration and exposition written in respect to the amphitheatre being struck by lightning, concerning which you had written to Heraclianus, the tribune, and master of offices, you may know has been reported to us.

"Dated the 16th, before the kalends of January, at Seridica (320), Acc. the 8th, before the ides of March, in the consulship of Crispus II and Constantine III, Caess, Coss., 321 A. D."—("Codex Theo.," lib. xvi, tit. 10, l. 1.)

The reader will note that nothing appears in the law, neither does

anything appear in the accompanying evidence, showing that Christians desired the law, or were in any way interested therein. It applied to all the subjects of the empire alike. The day is not mentioned, except by its heathen title. There is nothing in the restrictions placed upon it unlike the restrictions which already existed concerning many other pagan days. The following extract, from the work of an English barrister, is pertinent at this point:

"That the division of days into *juridici et ferati*, judicial and non-judicial, did not arise out of the modes of thought peculiar to the Christian world, must be known to every classical scholar. Before the age of Augustus the number of days upon which, out of reverence to the gods to whom they were consecrated, no trials could take place at Rome, had become a resource upon which a wealthy criminal could speculate as a means of evading justice; and Suetonius enumerates, among the praiseworthy acts of that emperor, the cutting off from the number thirty days, in order that crime might not go unpunished nor business be impeded."—("Feasts and Fasts," p. 6, by Edward V. Neale.)

After enumerating certain kinds of business which were allowed under these general laws, Mr. Neale adds, "Such was the state of the laws with respect to judicial proceedings while the empire was still heathen." Concerning the suspension of labor, we learn, from the same author, that—

"The practice of abstaining from various sorts of labor upon days consecrated by religious observance, like that of suspending at such seasons judicial proceedings, was familiar to the Roman world before the introduction of Christian ideas. Virgil enumerates the rural labors which might on festal days be carried on without intrenching upon the prohibitions of religion and right; and the enumeration shows that many works were considered as forbidden. Thus it appears that it was permitted to clean out the channels of an old water-course, but not to make a new one; to wash the herd or flock, if such washing was needful for their health, but not otherwise; to guard the crop from injury by setting snares for birds, or fencing in the grain; and to burn unproductive thorns."—(Ibid., p. 86.)

Sir Henry Spellman, speaking of the origin of English "court terms," says:

"I will, therefore, seek the original of our terms only from the Romans, as all other nations that have been subject to their civil and ecclesiastical monarch *do* and *must*.

"The ancient Romans, while they were yet heathens, did not, as we at this day, use certain continual portions of the *year* for a legal decision of controversies, but, out of superstitious conceit that some days were ominous and more unlucky than others (according to that of the Egyptians), they made one day to be *fastus* or *ferii day*, and another (as an Egyptian day) to be vacation or *nefastus;* seldom two

fast or law days together; yea, they sometimes divided one and the same day in this manner:

"*In modo fastus erat, mune nefastus erat.*

"The afternoon was term, the morning holy day. Nor were all their *fasti* applied to judicature, but some of them to other meetings and consultations of the commonwealth; so that, being divided into three sorts, which they called *fastos proprie*, *fastos endotercisos*, and *fastos comitiales*, containing together one hundred and eighty-four days, through all the months of the year there remained not properly to the prætor, as judicial triverbial days, above twenty-eight."—(Works, from original MS., in Bodleian Library, book ii, p. 74.)

Church historians have been obliged to recognize the purely heathen character of this legislation. Schaff says: "But the Sunday law of Constantine must not be overrated. He enjoined the observance, or rather forbade the public desecration, of Sunday, not under the name of *Sabbatum* or *Dies Domini*, but under its old astrological and heathen title, *Dies Solis*, familiar to all his subjects, so that the law was as applicable to the worshipers of Hercules, Apollo, and Mithras, as to the Christians. There is no reference whatever in his law either to the fourth commandment or to the resurrection of Christ."—("Church History," vol. iii, p. 380.)

Milman says: "The rescript, indeed, for the religious observance of the Sunday, which enjoined the suspension of all public business and private labor, except that of agriculture, was enacted, according to the apparent terms of the decree, for the whole Roman Empire. Yet, unless we had direct proof that the decree set forth the Christian reason for the sanctity of the day, it may be doubted whether the act would not be received by the greater part of the empire as merely adding one more festival to the *fasti* of the empire, as proceeding entirely from the will of the emperor, or even grounded on his authority as supreme pontiff, by which he had the plenary power of appointing holy-days. In fact, as we have before observed, the day of the sun would be willingly hallowed by almost all the pagan world, especially that part which had admitted any tendency toward the Oriental theology."—("History of Christianity," vol. ii, pp. 396, 397.)

No other legislation concerning Sunday appears for the next sixty-five years. Meanwhile, the Church was becoming paganized, the papacy was developing, the empire was tottering, and all things were getting ready for the dark ages. From the close of the fourth century to the close of the fifth the legislation was enlarged, including scores of other days, most of them pagan festivals, christened by new names, and but slightly modified in the manner of their observance. As church and state became more thoroughly united, the pagan idea that the civil law ought to regulate religious actions and religious belief was so fully developed that the state determined not only what men should do, but what men should believe. Civil law practically

decided what Christianity was. It defined orthodoxy and heresy, thus involving the whole realm of religious conscience in the meshes of political intrigue.

As the Holy Roman Empire grew upon the ruins of the pagan empire, it continued to secularize and corrupt Christianity. Civil legislation relative to Sunday and other festivals and fasts prevailed during the dark ages. Our Saxon ancestors, converted under this empire, received this inheritance, and transmitted through the Saxon and English laws the entire genius of Sunday legislation to our own time. The chain is unbroken which binds the Sunday law of to-day to the first pagan Sunday law of 321 A. D.

There was little or no development of the Sabbatic idea, as drawn from the fourth commandment, until the time of the Puritan reformation. Under the theory that the fourth commandment might be transferred from the seventh to the first day of the week, Sunday legislation took on the more distinctively Sabbatic type which has prevailed in America. The theocracy of the New England colonies, which made the civil government subservient to the Church, instituted the most rigorous Sunday legislation. These early colonial laws were not only rigid, but were rigidly enforced. Their power was short-lived. As the colonial governments gave way to the States, and the States became united in the nation, Sunday legislation was continually modified and its influence steadily declined. The laws still exist, but are disregarded by all classes of society, according to choice or convenience. Religious men assemble in conventions, speak through resolutions, and editorials bewail the state of things and talk of the necessity of a more rigid enforcement of the Sunday laws. No one heeds such talk, and no law is enforced. Year by year we drift further away from a religious regard for Sunday. The most cogent arguments driven into the public mind are like a nail driven into the weak mortar of a thin wall; it looks well till you attempt to hang a weight upon it, when it gives way, deepening the sense of failure. Hence we say, as at the beginning, either the Sunday laws are not grounded in Christianity, or the public conscience has become wickedly indifferent.

WHY THUS?

The real philosophy of the situation is this: Sunday laws, coupled with the false no-Sabbath theories which were developed in the second century, have depraved the public conscience and produced the very results over which good men now mourn. Granted, for sake of the argument, that Sunday has rightfully taken the place of the Sabbath, and ought to be observed in accordance with a Christian interpretation of the fourth commandment. The fact remains that the civil law, assuming control of religious actions, places itself between the human heart and God. It shuts out the divine authority. It forbids the conscience to rise above the human authority. The result is, no conscience. If, on the other hand, the observance of the Sunday, or the

enforcement of the law, be urged upon grounds of policy and expediency, each man instantly claims the right to judge for himself as to what is expedient or necessary. Divine authority alone can give a Sabbath. Human authority can give no more than a holiday.

The results which confront us indicate an underlying philosophy against which it is useless to fight. They show that the pagan conception, which makes the state the source of authority in religious matters, the arbiter of disputes, or the regulator of acts, is not only foreign to the true Christian conception, but is destructive of it. The Christianity of the fourth century was widely removed from the Christianity of the apostles. No one element did more to create this degeneracy than the interference by the state in matters of religion. No form of interference affected the life of the people more than legislation concerning holy-days and religious festivals. The effort which Puritanism made to lift the whole question to a higher level has failed because it persisted in the fundamental error that the state may justly legislate concerning religious duties. Religious sabbatizing is a duty which men owe to God alone. Civil law can make a holiday, can institute a day on which business and labor will cease; it can never make a Sabbath any more than it can make an honest man. All appeal to civil law concerning Sabbath-keeping is necessarily degrading, and opposed to the genius of Christianity. The Sunday laws have not become obsolete because men are comparatively more wicked than before, but because men have steadily risen above the pagan conception which permits the state thus to interfere. He who complains of the decline in regard for Sunday laws complains of an unavoidable fruitage which has always appeared and always will appear when the state interferes with religious matters.

Another result has developed in connection with our Sunday laws whereby the vilest and most nefarious business known to our civilization has intrenched itself behind them, and at the same time defies them. The enforced leisure which the Sunday laws and the customs concerning Sunday have brought about make Sunday the great harvest-day for the saloons and their associate evils. The Sunday laws prohibit many forms of legitimate business which our Christian civilization has come to allow, and any persistent effort to enforce the Sunday laws against the saloon is met by the saloonist with the counter-effort to enforce the laws against legitimate business. In the absence of any struggle with the saloon, nobody thinks of enforcing the laws against legitimate business, or against popular amusements. Meanwhile the rum-traffic, content to close the front door, if that be really insisted upon, goes forward, and will continue to go forward, unchecked. Legitimate business can not afford to be interfered with, and the liquor power, holding the club in its own hand, says, "Permit me to go forward, through the side-door at least, or I will give you endless trouble through the same law whereby you seek to interfere

with me." In many places, as in our Western cities, the liquor power is strong enough to openly defy every effort, and to push its business through the front door, regardless of law. Between the two methods, the rum-traffic has taken full possession of Sunday, and the larger half of its profits are gathered in on that day.

A still more deplorable evil has come upon the Church itself, through reliance upon the Sunday law, and through the acceptance of Sunday, which has neither Scriptural authority nor standing-room on the law of God. It has ceased to appeal to the law of God—except in a very weak way—as the source of authority in matters relative to the Sabbath, and has thereby become shorn of all real strength. Year by year the Church drifts further into the stream of Sunday desecration. The pulpit talks of the terrible disregard for Sunday which prevails, while the pews hasten out on Monday morning to pocket the profits of Sunday business and Sunday revelry. Thus, dependence on the civil law, and false theories concerning the abrogation of the Sabbath, have turned the heart of the Church itself away from the law of God, and left it to lean on a broken reed which is piercing it through.

The results are sad, but terribly real. They are legitimate, unavoidable, but none the less ruinous.

THE MENTAL FACULTIES OF MONKEYS.

By Madame CLÉMENCE ROYER.

WHEN we compare the mental faculties and social instincts of animals, even of monkeys, with those of the superior races of civilized men, the distance seems immeasurable, and to fill the gap impossible. But, if we take the lower races of mankind, the differences appear less marked, and even analogies arise. Many of the moral and mental faculties, in fact, which we observe among the quadrumana appear common to them with savage peoples on the one side, and with some of the higher mammalia on the other side, which have well-developed social instincts—with, for instance, dogs, horses, and elephants. The animals which man has domesticated are, as a rule, those which belong to social species, and live in the natural state in more or less numerous groups. And, among the monkeys, it is not the large ones, those which most resemble men in stature, that are most social and most susceptible of domestication, but the smaller ones, the tree-climbers.

The gorilla, of Western Africa, lives in patriarchal and polygamous families, in which many females and their young submit to the authority of a single adult, and the habits of the chimpanzee are similar; but the *Cynocephalæ*, most of the smaller species of the African

Continent, and American monkeys, live in considerable troops, in a kind of general sexual promiscuity, in which the love of the mothers for their young, very strong while they need it in their weakness, does not outlive their growth out of helpless infancy. Similar habits have been noticed among some savage races; and traditions are preserved among many people of a time when family bonds did not exist. But traces of more durable family bonds between monkeys of the same blood seem to exist among the chimpanzees and gorillas, where the appearance of particular and exclusive affection is combined with rivalry with the members of other families. Savage, in the "Boston Journal of Natural History," tells of a female chimpanzee which was observed in a tree with the male and a pair of young of different sexes. She first started to hurry down and run into the thicket with the male and the young female; but, seeing the young male left behind, she went back for him and had taken him in her arms when she was shot. Houzeau, in his "Études" ("Studies on the Mental Faculties of Animals as compared with those of Men"), compares this trait with the indifference with which the New Zealand mother saw Cook take away her son, probably forever, as she was expressly informed. Houzeau also finds traces of paternal affection in the protection that old anthropoid apes accord to the members of the polygamous tribe of which they are chiefs. This kind of affection can, however, hardly be said to exist among all men. There are numerous tribes in which the fathers do not know their own children, in which the names pass in the female line, and where a man's heirs are the children of his sisters. Striking examples of conjugal love are sometimes shown among monogamous monkeys. An incident in point is that of a female of an American species which, tired of holding her young one, called up the male to relieve her. Another story is that of the male in the Jardin des Plantes which became inconsolable and starved itself to death after its companion died.

In the way of language, monkeys manifest their passions, emotions, desires, and fears, by cries and gestures, emphasized by significant accents, which vary with the species. Monkeys and children, together with savages and uneducated people of civilized nations, manifest an inclination to mimic the gestures and motions of all persons whom they see. We think that this trait is especially prominent in monkeys, but thousands of instances might be cited to show that mankind, old and young, shares it with them. The attitude and the sagacity of monkeys are so human that some savages believe that it is out of maliciousness that they do not talk. In fact, a monkey might pass for a dumb man, because he does not articulate the consonants clearly, as we do; but not all men have this power of articulation in an equal degree. We have stammerers by birth and by habit. Some savage tribes have a scanty alphabet complicated by clicks and nasal and guttural sounds that can not be imagined till they are heard. All monkeys have voices,

and many of them have very strong ones. Excepting the solitary and taciturn orang-outang, the species which live in troops are chatterers, and keep up a great hubbub. The principal tones of their noisy and rapid language, with the frequent repetitions of the same sounds, may also be found in the languages of the most savage peoples. They are, for the most part, complex, guttural, and harsh articulations, with few variations. But the alphabets of some of the African and Melanesian nations are not much richer. In both, it is generally the labials which are wanting. Laughter is not wholly peculiar to men, for some monkeys have a noisy and expansive laugh analogous to ours. Cook has stated that natives of the New Hebrides express their joy by a kind of guttural whistle, analogous to the jerky, rattling laugh of some monkeys. Monkeys are also capable of showing sorrow and weeping; and it is possible to follow on their faces the equivalents of the physiognomical changes which in man answer to the expression of his various emotions. Among these are the drawing back of the corners of the mouth and the contraction of the lower eyelid, which constitute the monkey's smile, and the depression of the eyebrow and forehead in anger.

It can hardly be doubted at this day that monkeys have collective feasts, which Houzeau compares with the new-moon festivals of the negroes, Hottentots, and Papuans. Such assemblies take place among South American monkeys, when, having eaten up the resources of one place, they are about to emigrate to another. Duvancel witnessed, at Deobund, in India, a great meeting of monkeys, which the natives said took place regularly, after intervals of several years. They came up by thousands, from different directions, all marching with sticks in their hands. Arrived at the place of meeting, they threw their sticks into a great pile.

The feasts of the black chimpanzees of Africa are more like those of the negroes. The animals come together, it may be, fifty at a time, leaping, shouting, and drumming on old logs with sticks which they hold in their hands and feet. They are taking their first lessons in music, as it were; and it is remarkable that that music is upon the most rudimentary form of a drum, which is, besides, the universal primitive musical instrument of the lowest savage human races, and the only one which many of them possess. Tamed monkeys can beat the drum and play with castanets.

If we may believe popular stories, the quadrumana have some kind of funeral ceremonies. The Chinese Pharmacopœia speaks of a species of which, when any one of the band dies, all the others attend his funeral. A somewhat similar story, in which the dead monkey is covered with branches of trees, is told in "Purchas's Pilgrimmes"—a work which, however, is not of the highest scientific authority. But, however exaggerated these stories may be, it is not probable that monkeys are wholly indifferent to the death of their fellows—at least

that they are less concerned than those Caffres who bury only the bodies of their chiefs and their children.

Leadership among gorillas is decided by the law of the strongest. When the young gorillas become able, they put the old chiefs out of the way, and themselves take their places. So savage tribes dispatch their old men when they are no longer of use, or when they stand in the way of some ambitious aspirant. Monkeys fight by striking and clinching with their hands, and by trying to bite; they will clinch one another just as athletes do. The gorilla, coming down on its enemy, utters a cry like the war-cry of savages, and strikes upon its chest with its hands, as Houzeau says athletes frequently do. When attacked by an armed man, it aims to seize his gun or his club, and having got it tries to break it; but it does not try to use it as the man does. Other monkeys try to avoid man, but when attacked by him defend themselves courageously and throw stones and sticks at him; if they are on trees, breaking off limbs and fruits and nuts, and whatever they can put their hands upon. The primitive arms of mankind are likewise projectiles thrown by the hand like the Australian boomerang and the Indian's tomahawk, club, or lance. Free as monkeys are in throwing sticks, they do not seem to have ever come to the point of using their weapons as clubs or lances; and it is not consistent with their organization and habits that they should do so. Their fortresses are tree-tops, from which flying sticks and stones can do great execution, but to fight with clubs and lances they would have to stand upon the ground, where they would be at a great disadvantage. Both races, then, have chosen or evolved the weapons best suited to their anatomical organization. The habits of street-boys still show that man's first weapon-using instinct was to throw stones; and with this in view we can fancy the early battles when throngs of men fought by throwing showers of stones up into the trees at the monkeys, who, in their turn, threw branches down at them. Very few animals besides men and monkeys throw projectiles, but that is because they are the only ones that have prehensile hands. But elephants when angry will break down branches and pull up saplings with their trunks; and the ostrich kicks stones behind itself at the faces of its pursuers. It is the anatomical organization of the animal that determines its choice of arms.

Monkeys are susceptible of showing spontaneous preferences and friendships for others, even outside of their species, and can be, in their affections for human companions, as capricious as children. They share in man's aversion to snakes. In a state of nature they appear to manifest aversion and hostility to other animals, and particularly to other species of quadrumana. Orang-outangs exhibit an instinctive animosity against other monkeys, and assail them in every way. The tribe as a whole exhibit anger by nearly the same kind of acts as men do. A chimpanzee of Du Chaillu's had marked preferences for

particular things that were served at the table, and, when given other than what it desired, became irritated, threw down what was offered it, stamped its feet and uttered a peculiar cry, and acted, Du Chaillu says, just as a spoiled child would have done. A friend of the author, who had a little monkey, and was studying its instincts, said of it: "It is a badly brought-up child. It has all such a child's faults, and is intelligent enough to know when it is disobeying, and to hide itself when it intends to disobey." Dr. Abel's orang-outang showed its anger, when refused what it wanted, by rolling on the ground like a mad child and screaming, and would then go off and hide. The apes which Adanson chased in the forests of Senegal knit their eyebrows, gritted their teeth, and screamed; and the monkeys in the Jardin des Plantes and the Jardin d'Acclimatation, when irritated by the refusal of anything that has been tantalizingly shown them, throw themselves upon the gratings, make their ugliest faces, show their teeth, and scream and mutter.

"Greedy as a monkey" is a vulgar expression. Houzeau says that those persons who assert that monkeys will not have to do again with intoxicating drinks after having once been made their victims were more desirous of teaching a moral lesson than of telling the exact truth. Most tamed monkeys are ready enough to drink wine and brandy, and will help themselves to them. They like to get tipsy, and will indulge themselves whenever they can, in spite of chastisements. Their intoxication is characterized by the same symptoms as man's—weak knees, thick tongue, and unsteady movements. This identity of the effects of intoxication extends to other animals: asses and horses have been seen drunk; and dogs, which generally refuse wine, can be made to accept alcoholic drinks if they are sufficiently diluted and sweetened; while, as we have seen, monkeys of different species often exhibit antipathies to one another, those of the same species will assist one another, provided they are not sexual rivals. This trait of mutual helpfulness appears to exist in all animals that have órgans of prehension—as among the climbing birds and those insects which have mandibles. The instinct is quite well developed among monkeys, and those of the same family or troop exhibit traits of mutual assistance that might be very properly compared with those shown by men in their relations with one another. The monkeys in Sumatra, according to Cesare Moreno, are very troublesome in the gardens, and even in houses, when they can find entrance into them; and no kind of inclosure seems adequate to protect fruits and vegetables from their depredations. Forming a line in order to pass their spoil from hand to hand, they scale the walls, enter at the doors or windows, and leisurely pillage all that they can find. Then they retire to the woods, to dress themselves up in the gayly colored cloths which they may have stolen, while they have a particular fancy for whatever will give a metallic reflection. They

will divide their trinkets among one another, or quarrel about them, and dress themselves up in them in a grotesque style; and then, like children, having become tired of them, will leave them hanging on the branches or let them fall to the ground, and care no more for them. They seem to be thieves by instinct, for the mere pleasure of stealing, when they are not catering to their appetites; and they are capable of sacking a house and carrying off everything movable in it with the system and concert of a band of robbers. They observe a kind of discipline in their operations, and post their scouts, to inform them in season when it is time to run away; and this, when warned, they can do with wonderful simultaneousness.

Ulloa saw monkeys joining hands, six or eight together, to ford rivers. Dampier tells a very interesting story of the performances in this line of the monkeys of the Isthmus of Panama. We can see monkeys repeating the same exercise on a small scale for amusement in zoölogical gardens.

Travelers say that monkeys take up those of their number which are wounded in their battles. Savage observed the same thing done for chimpanzees when they were shot, and says that, when the wound does not immediately produce death, his fellows have been seen to put their hands over it to stop its bleeding, and, if this did not succeed, to apply leaves and sod. Houzeau relates an analogous story on the authority of the New-Hebrides islanders.

As men appropriate particular territories to themselves to the exclusion of all others, so the larger monkeys will drive away other animals from grounds they wish to occupy, with an efficiency that speaks well for their discipline and tactics.

The acuteness of the perception of domestic animals to approaching danger is well known. Monkeys exhibit it in an equal degree. Le Vaillant says that the bavian which went with him into Africa was his most trustworthy guardian, and signalized the approach of the slightest danger, whether by day or by night, even before the dogs could discover it; while the dogs acknowledged it their superior in this faculty, and at its look or nod would spring to this side or that, according as it indicated. The same monkey, though tamed, would answer the cries of the wild ones of its species when it heard them in the woods, but was afraid of them when it saw them. All travelers testify to the intelligence of monkeys in a wild state, and have much to say of the trouble they have in guarding against their devices. It is not considered safe to attack their troops, for they will defend themselves in concert and with energy, and in apparent security, from the tree-tops, where they are afraid of nothing but a gun.

The curiosity of animals is not always passive, and the attentive attitude they show is not always the effect of astonishment. They like to imitate, and to imitate they must observe. An orang-outang in the Jardin des Plantes, in Paris, being one day visited by Flourens

and Geoffroy Saint-Hilaire, observed the latter with earnest attention. As soon as it had thoroughly studied its visitor, it took a cane, bent itself over like an old man, and imitated his gait. Another orang-outang had learned how to get upon a chair and open a door-latch, which was otherwise out of its reach. The chair it was accustomed to use having been taken away, it went and got another from the corner, brought it to the door, and mounted it. Houzeau regards these facts as indicating the existence of an inventive faculty, of a decided intention looking to a fixed end, and a perception of the relation of cause and effect. A black chimpanzee of Buffon's knew how to unlock the door, and, if it did not find the key in the lock, would look for it. This monkey took its meals like a well-bred person, ate with a spoon and fork, used a plate, and served itself with wine. The anthropoid ape Mafuka, in the Zoölogical Garden of Dresden, knew all about the way to open the door of its cage. It would steal the key and hide it under its arm till it wanted to use it. At one time, after watching a carpenter at work, it got his gimlet and bored holes in its table. At meals it filled its own cup from the pitcher, and took care not to let it run over.

Mr. Cobs gave his young orang-outang half an orange, put the other half in a cupboard, and lay down on the sofa. Remarking some peculiarity in the movements of the orang, he pretended to be asleep. The animal came cautiously up to him to assure itself that he was asleep, then climbed upon the cupboard, took the rest of the orange and ate it, hid the peel carefully under the sticks in the fireplace, and then itself lay down. Such manner of action, says Tylor, can hardly be explained except by a train of thoughts supposing the existence of what among ourselves we call reason.

Bennett had to chide a young gibbon many times for putting things out of their places, among other things a cake of soap. One morning when he was writing he observed the monkey taking the soap, and watched its operations in such a manner that he should not himself be observed. Seeing him apparently occupied with his writing, the monkey went off with the soap in its hand. When it had got to the middle of the cabin, Bennett spoke to it in such a manner as not to startle it. When it perceived that it had been seen, it returned and put the soap in very nearly the place from which it had taken it.

Monkeys seem well adapted to perform some kinds of domestic offices, and acquit themselves gracefully in them. The natives of Madagascar train the short-tailed lemur for hunting, where it renders the same services as a dog. Pyrard says that in his time the colonists of Sierra Leone employed chimpanzees in carrying water and beating in mortars. They would carry the water in jars on their heads, but would drop their burdens if some one was not at hand to relieve them from the load. Acosta tells of a monkey belonging to the Governor of Cartagena, which they were accustomed to send with a bottle and

money to the wine-merchant's. It would never give up its money till it had got its wine, and would never touch that, although it was fond of it. Père Vincent Maria, procurator of the bare-footed Carmelites in the Indian Peninsula, tells of a *Macacus silenus* which imitated perfectly all the acts which it was shown how to perform. It would go at it so seriously and exactly that one could not help being surprised to see an animal do it all so well. Breton has in his Chinese pictures a representation of monkeys of one of the smaller species gathering tea-leaves on the tops of one of the steep ridges of Chansung. Williams doubts the truth of the story, but there is nothing in it outside of the probabilities. The ancient Egyptians obtained considerable services from the Cynocephalus.

Du Grandpré, of the French marine, speaks of a female chimpanzee that would heat the furnace on board the vessel. It was able to judge when the required degree of heat was reached, and would call the cook at the right moment. It would join the sailors in turning the capstan, would go on the yards with them, could pull ropes as well as any, and, observing that the ends were tied to keep them from hanging down, tied the ends which she held. Buffon mentions another female at Loango which could make the beds, sweep the house, and help turn the spit.

These monkeys had to be tamed before they could be taught; but, as they breed in captivity, Houzeau suggests that there is little doubt that the principal species are susceptible of domestication. Then it will only be necessary to train individuals for their special work. "Female monkeys," he adds, "might be employed in taking care of children. They would make excellent nurses, for their milk is rich in butter (ten per cent). These facts can hardly fail in time to strike the residents of European origin in Asia and Africa, where these animals are easy to get. We anticipate a time when these races, bred by man, will render great services in daily life and industry, and will contribute to the general progress. There is nothing in such a prediction which does not rest on scientific premises, and nothing in it to laugh at."—*Translated for the Popular Science Monthly from the Revue Scientifique.*

RECENT ADVANCES IN SOLAR ASTRONOMY.

By Professor CHARLES A. YOUNG.

WHILE during the past four years there has been no great or startling discovery in solar astronomy, there has been beyond question important progress at many points. Increased precision of numerical data has been attained, new methods of observation have been devised and put in practice, theories have been brought to trial with varying results of condemnation or approval, and mathematical

and physical investigations have been initiated which give some promise of solving the mysterious problems of the sun's surface-drift, and the periodicity of the spots. We propose in this paper briefly to summarize these advances.

The transit of Venus on December 6, 1882, was widely, and, on the whole, successfully observed. The Americans alone used photography to any great extent, and at the nine different stations (four of them in the southern hemisphere) nearly fifteen hundred photographs were obtained, of which over a thousand are good for measurement. The German heliometer parties were also successful; and a great body of contact and micrometric observations and some photographs were obtained by French, English, and Belgian parties. The publication of the photographic and heliometric results is waited for with much interest, but, for some reason, has been greatly delayed. The general impression, however, is that the results will not prove as consistent and accurate as had been hoped, the probable error remaining still pretty large, and indicating that transits can not compete in accuracy with some of the other methods of determining the solar parallax.

Since 1882 the Washington experiments of Professor Newcomb upon the velocity of light have been completed and published, along with a new and independent determination by Michelson, at Cleveland. The anomalies in Newcomb's earlier observations were traced to their source and removed, and now the results of both observers stand in very close and gratifying accordance. Newcomb's is 299,860 kilometres, Michelson's 299,853.

To go with this in fixing the solar parallax, we have the new determination of the constant of aberration, by Nyrén, of Pulkova, based on all the Pulkova observations up to 1883. This value, 20″·492, combined with the above velocity of light, and with Clark's value for the earth's equatorial radius (6378·2 kilometres), gives for the solar parallax 8″·794—almost absolutely accordant with that deduced from the heliometer observations of Mars, in 1877. The observations of the eclipses of Jupiter's satellites, by Professor Pickering's photometric method, now in progress at Cambridge and Paris, will also give an extremely valuable result when the twelve-year cycle is completed. It has fixed the precise number of seconds required for light to traverse the mean distance between the earth and the sun.

The most remarkable result which has been arrived at, with reference to the solar radiation since 1882, is the fact, ascertained by Langley, that we do not receive from the sun any of the low-pitched, slowly pulsing rays, such as are emitted from surfaces at or below the temperature of boiling water. The solar spectrum appears to be cut off squarely at the lower end, and this cutting off we know can not have been effected in the earth's atmosphere, because we receive from the moon just the very kind of rays that are missing from the solar spectrum, and that in considerable quantity as compared with the rays of

higher refrangibility. Langley finds these rays also abundant in the radiation from the electric arc, so that we can hardly suppose them *originally* absent from the solar energy. Unless there is some unsuspected error in the observations, it looks as if we must admit that they have been suppressed either in the atmosphere of the sun itself, or in interplanetary space.

Arrangements are now made by the English Solar-Physics Committee by which it is expected to secure at least one solar photograph, on a scale of eight inches to the sun's diameter, for every day of the year. These photographs are to be taken at Greenwich, at Dehra-Doon, in India; on the Island of Mauritius; and at some station in Australia: their comparison, measurement, and reduction are undertaken by the astronomer royal, at Greenwich. Much solar photographic work is also done at Potsdam and Meudon, but as yet nothing of the kind has been undertaken in the United States. Janssen has recently obtained some sun-spot photographs on a very large scale, but, so far as we know, they do not reveal anything new.

With the great twenty-three-inch telescope at Princeton, and on a few occasions, when the seeing has been fine enough to permit the use of powers of from six hundred and upward, the writer has found that, in many cases at least, the apparently club-like, almost bulbous, ends of the penumbral filaments are really fine, sharp-pointed hooks, reminding one of the curling tips of flames, or grass-blades bending over. Ordinarily they are seen as club-like, simply because of their brightness, and the irradiation and diffraction effects of moderate-sized object-glasses.

Some recent investigations upon the rotation of fluid masses, by Jukowsky, of Moscow, as applied to solar conditions by his colleague Belopolsky, seem to warrant a hope that the phenomena of surface-drift in longitude, and even the periodicity of the spots, may soon find a rational explanation as necessary results of the slow contraction of a non-homogeneous and mainly gaseous globe. The subject is difficult and obscure; but if it can be proved, as seems likely, that, on mechanical principles, the time of rotation of the central portions of such a whirling mass must be shorter than that of the exterior, then there will be, of necessity, an interchange of matter between the inside and outside of the sphere, a slow *surface*-drift from equator toward the poles, a more rapid *internal* current along and near the axis, from the poles toward the equator, a continual "boiling up" of internal matter on each side of the equator, and, finally, just such an eastward drift near the equator as is actually observed. Moreover, the form of the mass, and the intensity of the drift and consequent "boiling up" from underneath, might, and probably would, be subject to great periodical variations. Belopolsky's paper is given in the "Astronomische Nachrichten," No. 2722, and there is an English notice of it in "Nature" for May 20, 1886.

This theory falls in well with the facts established by Spoerer respecting the motion of the sun-spot zones, and the general, though slow, poleward movement of sun-spots.

Per contra, we have to note that Mr. Lockyer, in his recent lectures on solar physics, reported in "Nature," appears to be ready to accept the old theory that the spots, and their accompanying rings of prominences, are "splashes," due to the fall of meteoric matter upon the sun. He maintains that the spots appear *first*, and after them the faculæ and prominences; unless the writer is much mistaken, however, the reverse occurs sometimes, and even frequently—first faculæ and then spots among the faculæ.

The question of sun-spots and the weather is still debated with about the same vigor as ever; but, on the whole, there seems to be no reason to modify the opinions expressed in the text. While it is not at all unlikely that careful and continued investigation will result in establishing some *real* influence of sun-spots upon terrestrial meteorology, it is now also practically certain that this influence, if it exists at all, is extremely insignificant, and so masked and veiled as to be very difficult to determine. There is no ground or reason for the current speculations of certain newspaper writers who ascribe almost every great storm in the eastern part of the United States to some sun-spot or other.

The strange connection between solar disturbances and magnetic disturbances on the earth has, however, become more certain, if possible, than ever before, and is no longer anywhere disputed. In November, 1882, there was a very remarkable instance of an intense magnetic storm and polar aurora, simultaneous over all the earth, and coincident with the sudden outbreak of an enormous group of sun-spots.

Mr. Lockyer announces, as the result of a long series of observations upon sun-spot spectra, that there is a striking difference between the spot-spectra at the time of maximum and minimum sun-spot frequency; the lines that are most conspicuous by widening and darkening are by no means the same in the two cases. The most remarkable change is in the lines of iron, which are usually conspicuous, but almost vanish from the spot-spectrum at the sun-spot maximum.

The writer also has ascertained a curious and probably an important fact with reference to the structure of the spot-spectrum. Under extremely high dispersion it is found that the spectrum of the nucleus of a spot is not continuous, but is made up of countless fine, dark lines, for the most part touching or slightly overlapping, but leaving here and there unoccupied intervals which look like (and may be) bright lines. Each dark line is spindle-shaped—i. e., thicker in the middle where the spectrum is darkest, and tapers to a fine, faint, hair-like mark at each end; most of them can be traced across the penumbra-spectrum, and even out upon the general surface of the sun. The

average distance between the lines is about half that between the two components of b_4, so that within the b group the total number of dark lines is some 300, and there are seven or eight of the bright lines. This structure is most easily seen in the part of the spectrum between E and F; above F the lines are crowded so closely that it is difficult to resolve them, and below E they appear to grow wider, more diffuse, and fainter. It seems to indicate that the principal absorption which darkens the center of a sun-spot is not such as would be caused by minute solid or liquid particles—by smoke or cloud—which would give a continuous spectrum; but it is a true gaseous absorption, producing a veritable dark-line spectrum, in which the lines are countless and contiguous.

Since the notes to the second edition were written, great advances have been made in the study and mapping of the spectrum. While the maps of Kirchhoff and Ångström will always remain standards from the historical point of view, they are by no means adequate to represent what is seen by our present instruments, and a number of new ones have been recently constructed which must entirely supersede them for all detailed work. The most important of these are the maps of Thollon and Rowland. The former, for which its author received the Lalande prize of the French Academy of Sciences last January (1886), was constructed from *visual* observations with a great spectroscope having a train of his powerful compound bisulphide of carbon prisms. This map covers the whole length of the visible spectrum, and embodies the results of some two years' continuous labor; it was presented (as a drawing) to the Academy last year, but its engraving and publication are not yet completed, so that it will not be accessible for some time to come.

Professor Rowland's map is *photographic*, and extends from wave-length 5790, half-way between D and E, through the whole upper portion of the spectrum, and far beyond the visual limits. Its scale is from three to four times as large as that of Ångström. Five of the seven sheets are already published and in the hands of subscribers. The original negatives were made by means of a four-by-six-inch concave diffraction-grating, having about 90,000 lines, and a focal length of about thirty feet.

Professor C. P. Smyth, of Edinburgh, has also published a map of the whole visible spectrum, made with a very large diffraction spectroscope, having four-inch collimator and telescope, and a three-and-a-half by five-inch flat grating by Rowland. This map is constructed on a scale, not of wave-*lengths*, as usual, but of wave-*numbers*—i. e., the scale expresses for any given ray the number of its waves in the length of one "British inch." The dispersion is about the same as in Rowland's map. Important and very useful maps, on a slightly smaller scale, were published a year or two earlier by Fievez, of Brussels, and Vogel, of Potsdam.

In 1883 Egoroff, a Russian physicist, succeeded in showing that the great A and B groups of the solar spectrum are due to the *oxygen* in our atmosphere.

Cornu, by a very ingenious arrangement, in which he makes a small image of the sun, four or five millimetres in diameter, oscillate across the slit of a powerful spectroscope three or four times a second, has succeeded in bringing out conspicuously, and at a glance, the difference between the true solar and the telluric lines in the spectrum. The solar lines oscillate slightly as the eastern and western, the advancing and receding, limbs of the sun come alternately to the slit, while the telluric lines stand fast.

Mr. Lockyer has called in question the existence of the so-called "reversing layer" of the chromosphere, being disposed to hold that certain of the lines which we identify as belonging to the spectrum of any given substance, say iron, are due to absorption in upper and cooler regions of the solar atmosphere, while others are produced low down. In support of this idea, he adduces the observation that, at the Egyptian eclipse of 1882, certain of the so-called "iron-lines," between *b* and F, were much longer, though no brighter, than other "iron-lines" close by them, and remained much longer visible as the moon advanced to cover the chromosphere. There is not room to discuss the matter here. Those who believe that the Fraunhofer lines are mainly produced by that portion of the solar atmosphere which bathes and sustains the photospheric clouds, or lies immediately above them, would not quarrel with the idea that the upper regions also co-operate to a certain extent; but we see no proof from observation, as yet, that lines which are produced by the absorption of the upper regions of the solar atmosphere *are not also found in the lower.* The question undoubtedly is interesting and important: Does each region of the solar atmosphere have its own spectrum, peculiar and distinct from those of other regions above and below; all of them co-operating by simple summation to form the spectrum as we see it—or, on the other hand, as has been usually admitted, does the spectrum of the lowest stratum contain everything, while the spectra of the higher regions differ from it merely by defect? Eclipse observations may possibly decide it. Of course, if Mr. Lockyer is right, the fact would be a very effective argument for the theory of "compound elements," which theory, notwithstanding the failure of its "basic-line" defense, seems to be decidedly gaining ground in scientific opinion.

As to the bright-line spectrum of the chromosphere, no great discoveries have been made; a number of lines, probably fifteen or twenty, have been added by the writer to the two hundred and seventy-three long ago catalogued as constantly or occasionally appearing. Most of the new lines are in the violet and ultra-violet. Not one of them is below C.

Trouvelot has observed (or thinks he has) *dark* prominences—i. e.,

jets and clouds of hydrogen cooler than the luminous prominences, and so looking black when projected on a background of the hotter gas. Tacchini and Respighi have kept up a careful and systematic record of chromospheric phenomena in a statistical way.

During the past four years the most important investigations upon the solar radiation have been those of Langley. The results of the Mount Whitney Expedition of 1881, with those of certain supplementary investigations, were published in 1884. They fully confirm his earlier conclusion, that the previously received value of the solar constant should be largely increased, and from his data he fixes it at about thirty calories per square metre per minute instead of twenty-five. Of course, this involves a corresponding increase of twenty per cent in all the figures which are given to illustrate the immensity of the solar radiation in various ways.

It is worth noting also that Langley, following many French authorities, prefers to employ a smaller heat-unit than the *calory* used by the writer—the *gramme*-degree instead of the *kilogramme*-degree. His solar constant is the number of these *small* calories received per minute upon a square *centimetre*, and therefore on his scale of notation stands as three instead of thirty. We mention it, because this discordance in the definition of the calory has led to some confusion among those not entirely familiar with the subject. If we were to follow strictly the so-called c. g. s. system, the solar constant would be represented by a number still sixty times smaller—viz., 0·050 (gramme-degrees per centimetre per *second*).

Professor Langley has also, with the bolometer, carried the investigation of the invisible portion of the sun's heat-spectrum far beyond any of his predecessors, and has discovered and measured the wave-length of a large number of absorption-bands in this region; his results are confirmed by those of Becquerel and Abney, the latter operating by means of photography, and the former by means of the effect of the invisible infra-red radiations in quenching the phosphorescence of a suitably prepared screen.

Langley finds that the solar spectrum seems to terminate abruptly at a wave-length of about thirty thousand on Ångström's scale: he does not find in the sun's heat any of the long-waved, slowly-pulsating radiations, such as are emitted by bodies at or below the temperature of boiling water. We might think that they had been absorbed in the earth's atmosphere, were it not that he finds just these rays relatively abundant in the spectrum of lunar heat. He also finds them in the heat-spectrum of the electric arc, so that it is difficult to suppose that they do not *originally* exist in the solar spectrum. Unless there is some hidden fallacy or error in some of the observations, we are almost driven to admit that they have been absorbed in interplanetary space. But probably it will be best to await further confirmation of the experimental results before accepting so remarkable a conclusion.

At the eclipse of 1883, observed on Caroline Island, in the Pacific Ocean, by French and American parties, Professor Hastings made observations for the purpose of testing a theory he had framed that the outlying regions of the corona are merely a *diffraction* effect produced by the edge of the moon; the diffraction being not that due to the *regular* periodicity of light-vibrations, ordinarily discussed, but due to the probable continually occurring *discontinuity* or change of phase in the vibrations. It seems probable, from a not perfectly complete investigation, that such discontinuity might scatter light far beyond the limits of ordinary diffraction. He found during the eclipse, by an apparatus constructed expressly for the purpose, that the bright corona-line (1474 K) was always visible to a much greater distance from the sun on the side least deeply covered by the moon than on the other, as unquestionably ought to be the case if his theory were correct.

But the same thing would result from the diffusion of light by the air; and the French observers, and nearly all others who have discussed the matter, feel satisfied that this is the true explanation of what he saw. He himself now, we understand, thinks it not impossible that a thin cloud may have passed over the sun just at the critical moment, and so have vitiated his observation.

The discussion which has followed his publication seems to have only strengthened the older view, that the corona is a true solar appendage, an intensely luminous though inconceivably attenuated cloud of gas, fog, and dust, surrounding the sun, formed and shaped by solar forces.

The fact that comets, themselves mere airy nothings, have several times (the last instance was in 1882) passed absolutely through the corona without experiencing any sensible disturbance of path or structure, has, however, been always felt by many as an almost insuperable difficulty with this accepted theory, and more than anything else led Professor Hastings to propose his new hypothesis. But, on careful consideration, we shall find that our conceptions of the possible attenuation of shining matter near the sun will bear all the needed stretching without involving any absurdity. Recalling the phenomena of the electrical discharge in Crookes's tubes, it is clear that a "cloud," with perhaps only a single molecule to the cubic foot (but thousands of miles in thickness), would answer every luminous condition of the phenomena. And all the rifts and streamers, and all the peculiar structure and curved details of form, cry out against the diffraction hypothesis.

At present the most interesting debate upon the subject centers around the attempts of Dr. Huggins (first in 1883) to obtain photographs of the corona in full sunlight. He succeeded in getting a number of plates showing around the sun certain faint, elusive halo-forms which certainly look very coronal. Plans were made, and were carried out, in 1884, for using a similar apparatus upon the Riffelberg

in Switzerland, and since then at the Cape of Good Hope. So far nothing has been obtained, however, much in advance of Dr. Huggins's own first results. But since September, 1883, until very recently, the air, as every one knows, has been full of a fine haze, probably composed in the main of dust and vapor from Krakatoa, which has greatly interfered with all such operations. It is now fast clearing away, and, if Dr. Huggins's views are correct, it is reasonable to expect that a much greater measure of success will be reached next winter at the Cape, and perhaps during the present summer in England and Switzerland.

About the same time that Dr. Huggins was photographing in England, Professor Wright, of New Haven, was experimenting on the same subject in a different way. He reflected the sun's rays into a darkened room by a heliostat, cut out all but the blue and violet rays by a suitable absorbing-cell, and then formed an image of the sun and its surroundings upon a sensitive fluorescent screen, stopping out the sun's disk itself. He obtained on the screen, on more than one occasion, what he then believed and still believes to be a true image of the corona. But the aërial haze soon intervened to put an end to all such operations; for of course it is evident that success, whether by photography or by fluorescence, is possible only under conditions of unexceptionable atmospheric purity.

Both Professor Wright and Dr. Huggins base their hopes upon the belief, which seems to be warranted by the spectrum-photographs obtained during the Egyptian eclipse of May, 1882, that the light of the corona and of the upper regions of the sun's "atmosphere" is peculiarly rich in violet and ultra-violet rays—that the corona is far more brilliant to the photographic plate and to the fluorescent screen than to the eye.

Probably it must be admitted that at present the predominant opinion among astronomers and photographers is against the practicability of reaching the corona without an eclipse, by any such methods; at the same time, to the writer at least, the case appears by no means hopeless, and success is certainly most devoutly to be desired.

P. S.—The reports from the recent eclipse of August 29th, observed by British and American parties on the Island of Grenada, in the Southern West Indies, have just come to hand, and are strongly unfavorable to the reality of the coronal appearances obtained by Huggins and Wright in their attempts to render the corona visible without an eclipse.

Plates furnished by Mr. Huggins, and precisely similar to those which he has employed in his photographic experiments, were exposed by Captain Darwin during the totality (as well as before and after it), in an apparatus like Mr. Huggins's, with a time of exposure the same that he has been using, and were treated and developed according to his directions. The plates exposed during the totality *show no corona*

at all, the exposure proving insufficient to bring it out. Of course, this makes it extremely probable that what looks like the corona upon plates exposed to the uneclipsed sun is merely a fallacious ghost, due, as his opponents have always claimed, to something in his apparatus or process, or else to the scattered light in our atmosphere.

It is true, as Mr. Common points out, that the air was by no means satisfactorily clear during the eclipse, and the result, therefore, is not absolutely conclusive; but it must be conceded, and Mr. Huggins himself admits it, that the probability is now heavily against him.

Captain Darwin obtained good pictures of the corona with ordinary plates exposed for a longer time in the usual apparatus.

October 1, 1886.

CHEVREUL AT A HUNDRED.

By WILLIAM H. LARRABEE.

THE occasion of M. Chevreul's completing the one hundredth year of his age was celebrated in Paris on the 30th and 31st of August, with appropriate observances and honors. The festivities were begun in the National Society of Agriculture, whose custom it has been to elect M. Chevreul its president every other year. A committee of this society had been formed in April, under the presidency of M. Charles Brongniart, and had collected the sum of fifteen thousand francs for the purpose of striking a commemorative medal for the centenary. Addresses were delivered by Deputy Louis Passy, and, in presenting the medal, by M. Brongniart, who assured M. Chevreul that he was the object of the respect and admiration of all civilized nations. M. Chevreul replied: "All that I have heard causes me much embarrassment. And why? On account of the warmth of the profound and numerous sentiments which you have expressed. I never anticipated the honor that my comrades have paid me."

In the Academy of Sciences, whose regular meeting took place on the 30th, M. Blanchard, in the absence from Paris of President Admiral Jurien de la Gravière, took the chair and made the Academy's address. He remarked upon the session's occurring on that day, as if the hour had been chosen for the event, saying that "in the family it is on the eve of the marked day that the festival is given: was it not fitting that it should be the same in the Academy, our intellectual family, which we love more and more as we grow older?" He referred to the fact that he had, as President of the Academy, predicted this very event three years before, when M. Chevreul was entering upon his ninety-eighth year. Then, having made a general mention of the value of M. Chevreul's discoveries, he said: "The investigator, absorbed in his mission, dreams of nothing but of extending its domain. If he succeeds in unveiling facts of considerable inter-

est, he deserves well of science. If an application capable of furnishing the country a new source of wealth arises out of his labors, it is a glory to him; but the man of science finds his highest recompense when he has succeeded in spreading a comfort through the nation, and procuring for those who are disinherited of this world's goods a little of the luxury which it had seemed could only be obtained with wealth. Master, experimenter, philosopher, Monsieur Chevreul, you

CHEVREUL AT THE AGE OF FIFTY.

have known all of these triumphs. Again I tell you, nothing is wanting to the fullness of your life. By your stories of remote events of which you have been a witness, you have charmed those who in age might be your sons, and those, still more numerous, who might be your grandsons. Your memory, yet in its freshness, permits you still to instruct those who might be your great-grandchildren. After to-morrow, you will count the days, weeks, and years of your new century. That the years may be many is the wish of your fellows and admirers." M. Chevreul in reply cited as a proof that a man's reputation depends greatly upon the trial of time, the examples of Newton and Leibnitz, the latter of whom said, "Seek first the demonstration of causes." "Newton preferred the more fruitful idea, 'Seek the cause of phenomena, and when you have found it inquire what is the cause of that cause.' There is a wide gulf between the two formulas. To my mind Newton is greater than Leibnitz. Time has proved it." Representative scientific men of other countries, com-

missioned to pay their respects to M. Chevreul, were introduced to him: M. Van Beneden, from Belgium; M. Broch, from Norway; M. Bosscha, from the Netherlands; and M. Govi, from Italy. A congratulatory telegram, expressing a warm wish for health, vigor, and force, "to that remarkable patriarch of the world," was read from the University of Kazan, in Russia.

M. Pasteur, who was absent in the Jura, sent his compliments to the veteran, who, he said, while he modestly called himself the dean of students, ought to be styled the master of masters.

The Academy of Sciences of Berlin sent a congratulatory communication which, after reference severally to the more important results of M. Chevreul's principal researches, concluded: "Having thus represented in all its extent the activity that you have shown throughout your long life, we hold that your name should be inscribed in one of the first places on the list of the great men who have carried the scientific glory of France to the extremities of the earth."

In the evening M. Chevreul attended the opera, to witness a special performance in his honor.

The anniversary day itself was signalized by the unveiling, amid considerable pomp and ceremony, of a statue of M. Chevreul by M. Guillaume, in the hall of the new museum at the Jardin des Plantes. M. Chevreul entered the room leaning upon the arms of M. Bourlois, aged ninety-four, an old soldier of the empire, and of M. Frémy, the director of the museum. M. Frémy delivered the presentation address, a glowing eulogy of M. Chevreul's work. M. Zeller, President of the Five Academies, followed him, and expressed his satisfaction that in that magnificent hall, in which so many friends and foreigners had met, the French "Grand Old Man," who had modestly called himself the *decanus* of the French students, had been promoted by acclamation as the *decanus* of the students and *savants* of the universities and academies of the whole civilized world. M. Goblet, Minister of Public Instruction, spoke next, and, after referring to the fitness of the place for the statue, said M. Chevreul's life "has been one of incessant labor. He has loved work for its own sake, with a conscientious and disinterested affection; and by a just return he has obtained from it all the satisfaction which it could give—health, peace of mind, honor, and the delight of making great discoveries."

M. Janssen delivered the formal address of the Academy at the Odéon. He said, "It belongs to the Academy to tell you that if Science to-day lifts you upon that beautiful pedestal, it is because you have constantly loved her for herself, and have never thought of making of her a stepping-stone for your own advantage."

In the evening M. Chevreul attended a banquet which was given in his honor at the Hôtel-de-Ville.

Various testimonials were presented to the centenarian during the days of the festivities. Among them was a volume published

expressly for the occasion by M. Alcan, entitled "Hommage à M. Chevreul," written by Berthelot, who also presented a copy to the Academy, Charles Richet, Pouchet, Grimaux, E. Gautier, Dujardin Beaumetz, and Demarçay. The inhabitants of the Rue Chevreul sent him a fine nosegay. Another deputation presented him with a nosegay which, according to M. H. de Varigny's description in "Science," "was a masterpiece of art in the choice and distribution of colors. No more delicate allusion could be made to the venerable master's theory of complementary colors; and it was understood by the whole crowd, being exemplified in an unparalleled manner."

M. Gaston Tissandier has published in "La Nature" some incidents relating to M. Chevreul's career, additional to those which we gave in our sketch of him in August, 1885, or which throw a fuller light upon the facts presented in that article.

The life of the old philosopher has been up to this time spent between the Museum of Natural History, the Gobelins, and the Institute of France, and he has very seldom failed to be present at the Monday meetings of the Academy of Sciences. The memoirs which he has presented to his colleagues can hardly be counted. Among them may be mentioned one which he published in 1832 on the divining-rod, and another in 1853 on the tipping-tables, in which he scattered as with a breath all that was mysterious about the manifestations; and he rendered to science the service of demonstrating how the operator is the dupe of a charlatanism of which he is often the involuntary accomplice.

Although M. Chevreul had no taste for politics, he has been a man among his fellow-men, and a true patriot. During the Franco-Prussian War, when he was eighty-six years old, he remained in Paris through all the privations of the siege, and even stuck to the museum while more than eighty Prussian bombs were whizzing through it, making rubbish of the galleries and breaking up the glass cases. More than one of these projectiles burst close to the laboratory in which the brave old man was engaged in his work. He filed an indignant declaration of protest respecting this outrage, in the minutes of the Academy of the 9th of January, 1871, which runs as follows:

"The Garden of Medicinal Plants, founded in Paris by the edict of King Louis XIII, in the month of January, 1626—become the Museum of Natural History by decree of the Convention, on the 10th of June, 1793—was bombarded, in the reign of William I, King of Prussia, the Count of Bismarck being Chancellor, by the Prussian army, on the night of the 8th and 9th of January, 1871. Till then, it had been respected by all parties and by all powers, national and foreign.

"E. CHEVREUL, *Director.*"

It was on the occasion of this declaration that M. Chevreul wrote to the Abbé Lamazon a letter in which he designated himself the dean

of students, and thus gave origin to a title which has become famous in connection with his name. He said, "Let the expression of the sympathy you offer be given, not to the man of science, but to one who might call himself the Dean of the Students of France, since it has been given to him to continue without interruption, on the banks of the Seine, studies which were begun at the end of the last century in the beautiful land of Anjou."

M. Chevreul has a considerable library at the museum, which has been regularly increased by the accession of valuable books which his son, a bibliophilist like himself, has helped him to find. His grand life has been engaged in thought, and concentrated upon the studies from which such useful discoveries have resulted. He has kept himself in good condition and happy by work and moderation. His wife, who has now been dead for more than twenty years, attended to his comforts with all the devotion which such superior minds are able to invoke. His only son, a retired magistrate, lives at Dijon. The illustrious old man lives, therefore, alone, with his books for companions, by the aid of which he is able to converse with his brethren, the great ones of mankind, the Newtons and the Galileos. When not among his books, he is at his laboratory in the Gobelins, where he goes on with his experiments with a dexterity still quite juvenile.

M. Chevreul possesses a large fortune, which is augmented from year to year by the rewards of his scientific labors. His life therefore passes along placidly, enlivened by the pleasure of seeing the closing years of his career emphasized by ovations to his merit. He has witnessed the birth of all the scientific discoveries of our century, and has beheld the marvelous spectacle of the development of modern industry.

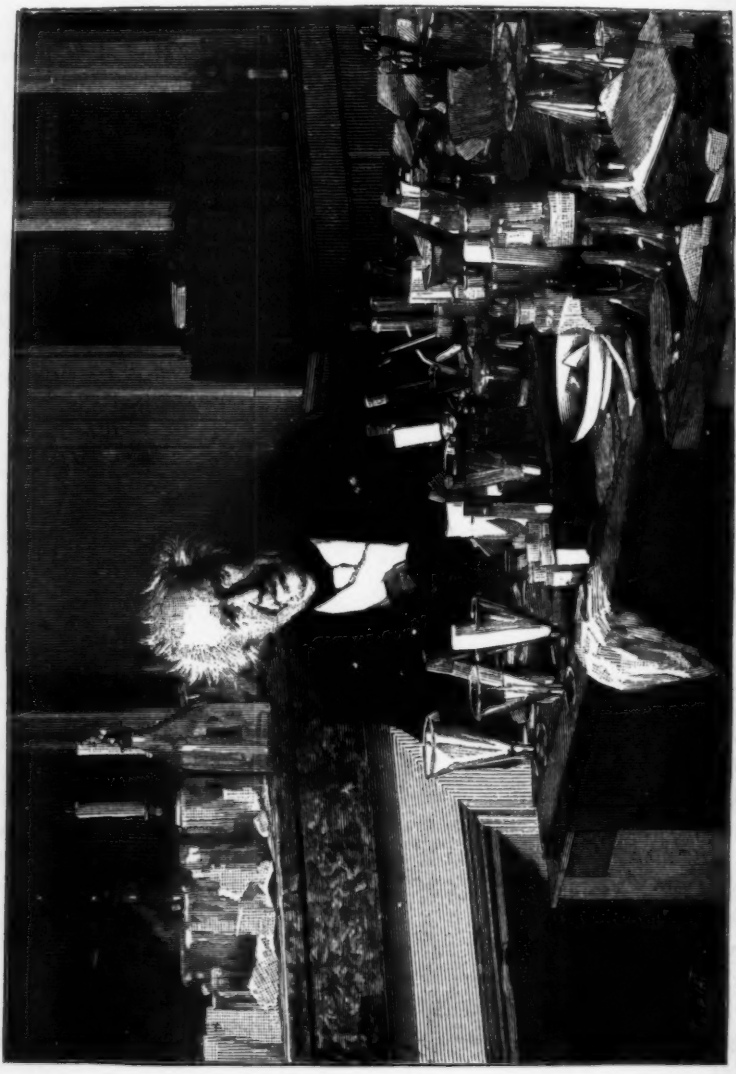
M. Chevreul is tall, and bears to this day an erect body. Of elegant manners and incomparable affability, he rarely fails to receive you with a smile. His head is a very fine one, with a broad and massive forehead, shaded with white locks. He is a man of wit as well as of genius. Recently, when engaging a new preparator for his laboratory, he said to him: "You must have a good deal of courage to take this place; I have killed four preparators already." We recollect, says M. Tissandier, seeing him at a ball in the Élysée, at midnight of a winter night, fresh and lively, surrounded by ladies whom he was gayly entertaining, with an exquisite and charming grace.

M. Chevreul is very sober. He drinks nothing but water and beer, except that, by the special request of Minister Goblet, he for the first time in his life departed from his abstinence to drink a glass of champagne in response to the sentiment "Vive la France!" at his century-banquet; and to his temperance, with his robust constitution and his prudent, regular, and industrious life, he doubtless owes his survival to so high an age.

It is a grand and beautiful spectacle, M. Tissandier concludes, that

M. Chevreul gives us, like that of an old oak overshadowing generation after generation of younger trees.

A partial conception of the length of M. Chevreul's still useful activity, and of the extent of his contributions to human welfare, may be gained by recollecting that, his first important work having been



M. Chevreul in his Hundredth Year at Work in his Laboratory. (From a photograph by M. David.)

published in 1806, he has been engaged for more than eighty years in fruitful investigations. As early as 1825, or sixty-one years ago, he was spoken of in "The Lancet" (May 28th) as "one of the most able chemists of the present day in France." He was then pursuing his

studies in saponification, and had given to the world star or adamantine candles, which were a greater improvement over the tallow-dips and dim lamps which the common people of that day had to get along with than the electric light is over our gas-lights and petroleum-lamps.

An item recently appeared in the newspapers saying that the other day his Excellency Tcheou-Meou-Ki, Director of the Chinese Mission of Public Instruction, paid a visit, with the mandarins attached to his person, to M. Chevreul in Paris. He handed to the illustrious chemist a Chinese document expressing in old characters every wish for his happiness and long life. It appears that there is living at this moment in China a Chinese *savant* who at the age of one hundred years has just passed his examination, and been admitted a member of the highest academy of the mandarins. The interpreter explained to M. Chevreul that his Chinese visitors considered that the fact that two *savants* a hundred years of age were living, one in France and the other in China, was a link connecting the learning of the two countries.

A correspondent of the "Pall Mall Gazette" recently visited M. Chevreul in his study bedroom at nine o'clock in the evening. He found him in bed, reading a play of Molière's, "and as cheery and hearty as a young man of twenty. He has decidedly an ancient look about him. His skin is well furrowed and wrinkled, and his hand shaky; but his eyes are not dim, nor is his natural mental strength abated. His memory is something marvelous. He remembered the horrors and bloody days of the Terror as vividly as the struggles and rise of the Third Republic." He talked about the theatres, Shakespeare, and Molière, whom, like a true Frenchman, he preferred, and added: "I don't know if among the English there is the same admiration for the classics as in France. We have always professed a great love for the classics, but the word 'classic' is too often applied to things that have nothing classic about them. Then we have other schools, the romantic and others. But I don't find much in recent writers. They have got a great many new words, but work on the old ideas. They keep on reproducing the old ideas over and over again, and do not give us many new thoughts." And he repeated several times, "It is very easy to give new names to very old things."

The old man, says the correspondent, "prattled on from one subject to another, speaking slowly and distinctly. 'We have in France,' he observed, 'a school that has a considerable number of adherents who say that man was descended from the monkeys. But if you accept that doctrine, you do away with the perfectibility of species.' M. Chevreul does not always lie in bed and read Molière. Until last December he went about as well as he had done fifty years before. Now he goes about the garden and the museums, attends the Academy of Sciences every week, and frequently reads papers; goes regularly to the meetings of the Agricultural Society and the offices of the 'Jour-

nal des Savants.' He always enjoys good health, and 'eats more than I do,' says M. Chevreul, *fils*." His temperance grew out of a repugnance which he contracted in youth to wines and liquors, and extends to smoking.

His favorite topic is colors, respecting which, our correspondent says, "he would insist on sitting up in bed and giving a demonstration on the propagation of colors. His strong point was that the 'colors are in us, and the cause in the things we look at' (*de hors*). Although he had talked a great deal during the day, there was no stopping him when once the started on the color question, or getting him to change the subject; and when we rose to leave, he protested that we were going away because his exposition wearied us." He is as earnest and enthusiastic a student yet as if he had another hundred years before him. "No man, perhaps, has seen his country pass through so many revolutions, and has lived under so many *régimes* as M. Chevreul. He remembers Louis XVI. His recollections of the Revolution and the Directoire are clear, though he was not then at Paris. He can call up pictures of the glory and the dignity of the First Empire. He has lived under the First Restoration, the Hundred Days, the Restoration of 1815, the Legitimist rule of 1830, the Republic of 1848, the Second Empire of 1852, and the Third Republic—in all eleven *régimes*, which is tolerably good for one lifetime."

The lesson has been drawn from M. Chevreul's life of what one writer styles "the physical wholesomeness of sustained labor." Cases of extreme longevity are usually found either among persons who live in almost complete inactivity of mind and are thus subject to no wear whatever from their nervous and intellectual faculties, or else among those who spend their lives in constant, vigorous thought. Persons of the class between these, who learn and pursue some business which in time becomes largely a matter of routine and ceases to call out exertion of the powers, usually die early, or at a moderate old age. Hence, the wonderful brightness and activity which we sometimes admire among very old persons, is not so wonderful after all, but is a part of their old age, and one of the causes that have enabled them to enjoy it. And the general rule is sustained, in the case of M. Chevreul, as in the case of numerous other men who have served the world or are serving it at ages far beyond threescore and ten, that "the harmonious development of all the many-sided aspects of man is the most conducive to the health of the individual, and that the training of the brain may be as valuable as the training of the muscles."

GEOLOGY OF THE ATLANTIC OCEAN.*

By Sir WILLIAM DAWSON,
PRINCIPAL OF McGILL COLLEGE, MONTREAL.

I.

THE geological history of the Atlantic depression of the earth's crust, and its relation to the continental masses which limit it, may furnish a theme at once generally intelligible and connected with great questions as to the structure and history of the earth, which have excited the attention alike of physicists, geologists, biologists, geographers, and ethnologists. If we imagine an observer contemplating the earth from a convenient distance in space, and scrutinizing its features as it rolls before him, we may suppose him to be struck with the fact that eleven sixteenths of its surface are covered with water, and that the land is so unequally distributed that from one point of view he would see a hemisphere almost exclusively oceanic, while nearly the whole of the dry land is gathered in the opposite hemisphere. He might observe that the great oceanic area of the Pacific and Antarctic Oceans is dotted with islands—like a shallow pool with stones rising above its surface—as if its general depth were small in comparison with its area. He might also notice that a mass or belt of land surrounds each pole, and that the northern ring sends off to the southward three vast tongues of land and of mountain-chains, terminating respectively in South America, South Africa, and Australia, toward which feebler and insular processes are given off by the Antarctic continental mass. This, as some geographers have observed, gives a rudely three-ribbed aspect to the earth, though two of the three ribs are crowded together and form the Europ-Asian mass or double continent, while the third is isolated in the single Continent of America. He might also observe that the northern girdle is cut across, so that the Atlantic opens by a wide space into the Arctic Sea, while the Pacific is contracted toward the north, but confluent with the Antarctic Ocean. The Atlantic is also relatively deeper and less cumbered with islands than the Pacific, which has the higher ridges near its shores, constituting what some visitors to the Pacific coast of America have not inaptly called the "back of the world," while the wider slopes face the narrower ocean, into which for this reason the greater part of the drainage of the land is poured. The Pacific and Atlantic, though both depressions or flattenings of the earth, are, as we shall find, different in age, character, and conditions; and the Atlantic, though the smaller, is the older, and from the geological point of view, in some respects, the more important of the two. If our imaginary observer had the means of knowing anything of the rock formations of the continents,

* From the inaugural address of the President of the British Association for the Advancement of Science, delivered at Birmingham, England, September 1, 1886.

he would notice that those bounding the North Atlantic are in general of great age, some belonging to the Laurentian system. On the other hand, he would see that many of the mountain-ranges along the Pacific are comparatively new, and that modern igneous action occurs in connection with them. Thus he might be led to believe that the Atlantic, though comparatively narrow, is an older feature of the earth's surface, while the Pacific belongs to more modern times. But he would note in connection with this that the oldest rocks of the great continental masses are mostly toward their northern ends, and that the borders of the northern ring of land and certain ridges extending southward from it constitute the most ancient and permanent elevations of the earth's crust, though now greatly surpassed by mountains of more recent age nearer the equator.

Before leaving this general survey we may make one further remark. An observer looking at the earth from without would notice that the margins of the Atlantic and the main lines of direction of its mountain-chains are northeast and southwest, and northwest and southeast, as if some early causes had determined the occurrence of elevations along great circles of the earth's surface tangent to the polar circles. We are invited by the preceding general glance at the surface of the earth to ask certain questions respecting the Atlantic: 1. What has at first determined its position and form? 2. What changes has it experienced in the lapse of geological time? 3. What relations have these changes borne to the development of life on the land and in the water? 4. What is its probable future? Before attempting to answer these questions, which I shall not take up formally in succession, but rather in connection with each other, it is necessary to state as briefly as possible certain general conclusions respecting the interior of the earth. It is popularly supposed that we know nothing of this beyond a superficial crust perhaps averaging fifty thousand to one hundred thousand feet in thickness. It is true we have no means of exploration in the earth's interior, but the conjoined labors of physicists and geologists have now proceeded sufficiently far to throw much inferential light on the subject, and to enable us to make some general affirmations with certainty; and these it is the more necessary to state distinctly, since they are often treated as mere subjects of speculation and fruitless discussion:

1. Since the dawn of geological science, it has been evident that the crust on which we live must be supported on a plastic or partially liquid mass of heated rock, approximately uniform in quality under the whole of its area. This is a legitimate conclusion from the wide distribution of volcanic phenomena, and from the fact that the ejections of volcanoes, while locally of various kinds, are similar in every part of the world. It led to the old idea of a fluid interior of the earth, but this is now generally abandoned, and this interior heated and plastic layer is regarded as merely an under-crust.

2. We have reason to believe, as the result of astronomical investigations, that, notwithstanding the plasticity or liquidity of the under-crust, the mass of the earth—its nucleus, as we may call it—is practically solid, and of great density and hardness. Thus we have the apparent paradox of a solid yet fluid earth; solid in its astronomical relations, liquid or plastic for the purposes of volcanic action and superficial movements.

3. The plastic sub-crust is not in a state of dry, igneous fusion, but in that condition of aqueo-igneous or hydro-thermic fusion which arises from the action of heat on moist substances, and which may either be regarded as a fusion or as a species of solution at a very high temperature. This we learn from the phenomena of volcanic action, and from the composition of the volcanic and plutonic rocks, as well as from such chemical experiments as those of Daubrée and of Tilden and Shenstone.

4. The interior sub-crust is not perfectly homogeneous, but may be roughly divided into two layers or magmas, as they have been called—an upper, highly siliceous or acidic, of low specific gravity and light-colored, and corresponding to such kinds of plutonic and volcanic rocks as granite and trachyte; and a lower, less siliceous or more basic, more dense, and more highly charged with iron, and corresponding to such igneous rocks as the dolerites, basalts, and kindred lavas. It is interesting here to note that this conclusion, elaborated by Durocher and Von Waltershausen, and usually connected with their names, appears to have been first announced by John Phillips in his "Geological Manual," and as a mere common-sense deduction from the observed phenomena of volcanic action and the probable results of the gradual cooling of the earth. It receives striking confirmation from the observed succession of acidic and basic volcanic rocks of all geological periods and in all localities. It would even seem, from recent spectroscopic investigations of Lockyer, that there is evidence of a similar succession of magmas in the heavenly bodies, and the discovery by Nordenskiöld of native iron in Greenland basalts affords a probability that the inner magma is in part metallic.

5. Where rents or fissures form in the upper crust, the material of the lower crust is forced upward by the pressure of the less supported portions of the former, giving rise to volcanic phenomena either of an explosive or quiet character, as may be determined by contact with water. The underlying material may also be carried to the surface by the agency of heated water, producing those quiet discharges which Hunt has named crenitic. It is to be observed here that explosive volcanic phenomena and the formation of cones are, as Prestwich has well remarked, characteristic of an old and thickened crust; quiet ejection from fissures and hydrothermal action may have been more common in earlier periods, and with a thinner over-crust.

6. The contraction of the earth's interior by cooling and by the

emission of material from below the over-crust has caused this crust to press downward, and therefore laterally, and so to effect great bends, folds, and plications; and these, modified subsequently by surface denudation, constitute mountain-chains and continental plateaus. As Hall long ago pointed out, such lines of folding have been produced more especially where thick sediments had been laid down on the sea-bottom. Thus we have here another apparent paradox—namely, that the elevations of the earth's crust occur in the places where the greatest burden of *détritus* has been laid down upon it, and where, consequently, the crust has been softened and depressed. We must beware, in this connection, of exaggerated notions of the extent of contraction and of crumpling required to form mountains. Bonney has well shown, in lectures delivered at the London Institution, that an amount of contraction almost inappreciable in comparison with the diameter of the earth would be sufficient; and that, as the greatest mountain-chains are less than one six-hundredth of the earth's radius in height, they would, on an artificial globe a foot in diameter, be no more important than the slight inequalities that might result from the paper gores overlapping each other at the edges.

7. The crushing and sliding of the over-crust implied in these movements raise some serious questions of a physical character. One of these relates to the rapidity or slowness of such movements, and the consequent degree of intensity of the heat developed, as a possible cause of metamorphism of rocks. Another has reference to the possibility of changes in the equilibrium of the earth itself as resulting from local collapse and ridging. These questions in connection with the present dissociation of the axis of rotation from the magnetic poles, and with changes of climate, have attracted some attention, and probably deserve further consideration on the part of physicists.

In so far as geological evidence is concerned, it would seem that the general association of crumbling with metamorphism indicates a certain rapidity in the process of mountain-making, and consequent development of heat, and the arrangement of the older rocks around the Arctic basin forbids us from assuming any extensive movement of the axis of rotation, though it does not exclude changes to a limited extent. I hope that Professor Darwin will discuss these points in his address to the Physical Section. I wish to formulate these principles as distinctly as possible, and as the result of all the long series of observations, calculations, and discussions since the time of Werner and Hutton, and in which a vast number of able physicists and naturalists have borne a part, because they may be considered as certain deductions from our actual knowledge, and because they lie at the foundation of a rational physical geology.

Keeping in view these general conclusions, let us now turn to their bearing on the origin and history of the North Atlantic. Though the Atlantic is a deep ocean, its basin does not constitute so

much a depression of the crust of the earth as a flattening of it; and this, as recent soundings have shown, with a slight ridge or elevation along its middle, and banks or terraces fringing the edges, so that its form is not so much that of a basin as that of a shallow plate with its middle a little raised. Its true, permanent margins are composed of portions of the over-crust folded, ridged up, and crushed as if by lateral pressure emanating from the sea itself. We can not, for example, look at a geological map of America without perceiving that the Appalachian ridges, which intervene between the Atlantic and the St. Lawrence Valley, have been driven bodily back by a force acting from the east, and that they have resisted this pressure only where, as in the Gulf of St. Lawrence and the Catskill region of New York, they have been protected by outlying masses of very old rocks, as, for example, by that of the Island of Newfoundland, and that of the Adirondack Mountains. The admirable work begun by my friend and fellow-student Professor James Nicol, followed up by Hicks, Lapworth, and others, and now, after long controversy, fully confirmed by the recent observations of the geological survey of Scotland, has shown the most intense action of the same kind on the east side of the ocean in the Scottish Highlands; and the more widely distributed Eozoic rocks of Scandinavia may be appealed to in further evidence of this.

If we now inquire as to the cause of the Atlantic depression, we must go back to a time when the areas occupied by the Atlantic and its bounding coasts were parts of a shoreless sea in which the earliest gneisses or stratified granites of the Laurentian age were being laid down in vastly extended beds. These ancient crystalline rocks have been the subject of much discussion and controversy, and, as they constitute the lowest and probably the firmest part of the Atlantic sea-bed, it is necessary to inquire as to their origin and history. Dr. Bonney, the late President of the Geological Society, in his anniversary address, and Dr. Sterry Hunt, in an elaborate paper communicated to the Royal Society of Canada, have ably summed up the hypotheses as to the origin of the oldest Laurentian beds. At the basis of these hypotheses lies the admission that the immensely thick beds of orthoclase gneiss, which are the oldest stratified rocks known to us, are substantially the same in composition with the upper or siliceous magma or layer of the under-crust. They are, in short, its materials either in their primitive condition or merely rearranged. One theory considers them as original products of cooling, owing their lamination merely to the successive stages of the process. Another view refers them to the waste and rearrangement of the materials of a previously massive granite. Still another holds that all our granites really arise from the fusion of old gneisses of originally aqueous origin; while a fourth refers the gneisses themselves to molecular changes effected in granite by pressure.

It will be observed, in regard to these theories, that none of them suppose that the old gneiss is an ordinary sediment, but that all regard it as formed in exceptional circumstances, these circumstances being the absence of land and of sub-aërial decay of rock, and the presence wholly or principally of the material of the upper surface of the recently hardened crust. This being granted, the question arises, Ought we not to combine these several theories and to believe that the cooling crust has hardened in successive layers from without inward; that at the same time fissures were locally discharging igneous matter to the surface; that matter held in suspension in the ocean, and matter held in solution by heated waters rising from beneath the outer crust, were mingling their materials in the deposits of the primitive ocean? It would seem that the combination of all these agencies may safely be invoked as causes of the pre-Atlantic deposits. This is the eclectic position which I endeavored to maintain in my address before the Minneapolis meeting of the American Association in 1883, and which I still hold to be in every way probable. That these old gneisses were deposited not only in what is now the bed of the Atlantic, but also on the great continental areas of America and Europe, any one who considers the wide extent of these rocks represented on the map recently published by Professor Hull can readily understand.

It is true that Hull supposes that the basin of the Atlantic itself may have been land at this time, but there is no evidence of this, more especially as the material of the gneiss could not have been *détritus* derived from sub-aërial decay of rock. Let us suppose, then, the floor of Old Ocean covered with a flat pavement of gneiss, or of that material which is now gneiss, the next question is, How and when did this original bed become converted into sea and land? Here we have some things certain, others most debatable. That the cooling mass, especially if it were sending out volumes of softened rocky material, either in the exo-plutonic or in the crenitic way, and piling this on the surface, must soon become too small for its shell, is apparent; but when and where would the collapse, crushing, and wrinkling inevitable from this cause begin? Where they did begin is indicated by the lines of mountain-chains which traverse the Laurentian districts; but the reason why is less apparent. The more or less unequal cooling, hardening, and conductive power of the outer crust we may readily assume. The driftage unequally of water-borne *détritus* to the southwest by the bottom-currents of the sea is another cause, and, as we shall soon see, most effective. Still another is the greater cooling and hardening of the crust in the polar regions, and the tendency to collapse of the equatorial protuberance from the slackening of the earth's rotation. Besides these, the internal tides of the earth's substance at the times of solstice would exert an oblique pulling force on the crust, which might tend to crack it along diagonal lines.

From whichever of these causes, or the combination of the whole, we know that within the Laurentian time folded portions of the earth's crust began to rise above the general surface in broad belts running from northeast to southwest, and from northwest to southeast, where the older mountains of Eastern America and Western Europe now stand, and that the subsidence of the oceanic areas allowed by this crumbling of the crust permitted other areas on both sides of what is now the Atlantic to form limited table-lands. This was the beginning of a process repeated again and again in subsequent times, and which began in the Middle Laurentian, when for the first time we find beds of quartzite, limestone, and iron-ore, and graphitic beds, indicating that there were already land and water, and that the sea, and perhaps the land, swarmed with animal and plant life, of forms unknown to us, for the most part, now.

Independently of the questions as to the animal nature of Eozoön, I hold that we know, as certainly as we can know anything inferentially, the existence of these primitive forms of life. If I were to conjecture what were the early forms of plant and animal life, I would suppose that just as in the Palæozoic the acrogens culminated in gigantic and complex forest-trees, so in the Laurentian the algæ, the lichens, and the mosses grew to dimensions and assumed complexity of structure unexampled in later times, and that in the sea the humbler forms of Protozoa and Hydrozoa were the dominant types, but in gigantic and complex forms. The land of this period was probably limited, for the most part, to high latitudes, and its aspect, though more rugged and abrupt, and of greater elevation, must have been of that character which we still see in the Laurentian hills. The distribution of this ancient land is indicated by the long lines of old Laurentian rock extending from the Labrador coast and the north shore of the St. Lawrence, and along the eastern slopes of the Appalachians in America, and the like rocks of the Hebrides, the Western Highlands, and the Scandinavian mountains. A small but interesting remnant is that in the Malvern Hills, so well described by Holl.

It will be well to note here and to fix on our minds that these ancient ridges of Eastern America and Western Europe have been greatly denuded and wasted since Laurentian times, and that it is along their eastern sides that the greatest sedimentary accumulations have been deposited. From this time dates the introduction of that dominance of existing causes which forms the basis of uniformitarianism in geology, and which had to go on with various and great modifications of detail through the successive stages of the geological history till the land and water of the northern hemisphere attained to their present complex structure. So soon as we have a circumpolar belt or patches of Eozoic land and ridges running southward from it, we enter on new and more complicated methods of growth of the continents and seas. Here we are indebted to Le Conte for clearly pointing out that our original

Eozoic tracts of continent were in the earliest times areas of deposition, and that the first elevations of land out of the primeval ocean must have differed in important points from all that have succeeded them; but they were equally amenable to the ordinary laws of denudation. Portions of these oldest crystalline rocks, raised out of the protecting water, were now eroded by atmospheric agents, and especially by the carbonic acid then existing in the atmosphere, perhaps more abundantly than at present, under whose influence the hardest of the gneissic rocks gradually decay. The Arctic lands were subjected, in addition, to the powerful mechanical force of frost and thaw. Thus every shower of rain and every swollen stream would carry into the sea the products of the waste of land, sorting them into fine clays and coarser sands; and the cold currents which cling to the ocean-bottom, now determined in their courses, not merely by the earth's rotation, but also by the lines of folding on both sides of the Atlantic, would carry southwestward, and pile up in marginal banks of great thickness, the *débris* produced from the rapid waste of the land already existing in the Arctic regions. The Atlantic, opening widely to the north, and having large rivers pouring into it, was especially the ocean characterized, as time advanced, by the prevalence of these phenomena.

Thus throughout the geological history it has happened that, while the middle of the Atlantic has received merely organic deposits of shells of Foraminifera and similar organisms, and this probably only to a small amount, its margins have had piled upon them beds of *détritus* of immense thickness. Professor Hall, of Albany, was the first geologist who pointed out the vast cosmic importance of these deposits, and that the mountains of both sides of the Atlantic owe their origin to these great lines of deposition; along with the fact, afterward more fully insisted upon by Rogers, that the portions of the crust which received these masses of *débris* became thereby weighted down and softened, and were more liable than other parts to lateral crushing. Thus in the later Eozoic and early Palæozoic times, which succeeded the first foldings of the oldest Laurentian, great ridges were thrown up, along the edges of which were beds of limestone, and on their summits and sides thick masses of ejected igneous rocks. In the bed of the central Atlantic there are no such accumulations. It must have been a flat, or slightly ridged, plate of the ancient gneiss, hard and resisting, though perhaps with a few cracks, through which igneous matter welled up, as in Iceland and the Azores in more modern times. In this condition of things we have causes tending to perpetuate and extend the distinctions of ocean and continent, mountain and plain, already begun; and of these we may more especially note the continued subsidence of the areas of greatest marine deposition. This has long attracted attention, and affords very convincing evidence of the connection of sedimentary deposit as a cause with the subsidence of the crust.

We are indebted to a French physicist, M. Faye, for an important suggestion on this subject. It is that the sediment accumulated along the shores of the ocean presented an obstacle to radiation, and consequently to cooling of the crust, while the ocean-floor, unprotected and unweighted, and constantly bathed with currents of cold water, having great power of convection of heat, would be more rapidly cooled, and so would become thicker and stronger. This suggestion is complementary to the theory of Professor Hall, that the areas of greatest deposit on the margins of the ocean are necessarily those of greatest folding and consequent elevation. We have thus a hard, thick, resisting ocean-bottom which, as it settles down toward the interior, under the influence of gravity, squeezes upward and folds and plicates all the soft sediments deposited on its edges. The Atlantic area is almost an unbroken cake of this kind. The Pacific area has cracked in many places, allowing the interior fluid matter to ooze out in volcanic ejections. It may be said that all this supposes a permanent continuance of the ocean-basins, whereas many geologists postulate a mid-Atlantic continent to give the thick masses of *détritus* found in the older formations both in Eastern America and Western Europe, and which thin off in proceeding into the interior of both continents. I prefer, with Hall, to consider these belts of sediments as in the main the deposits of northern currents, and derived from Arctic land, and that, like the great banks of the American coast at the present day, which are being built up by the present Arctic current, they had little to do with any direct drainage from the adjacent shore. We need not deny, however, that such ridges of land as existed along the Atlantic margins were contributing their quota of river-borne material, just as on a still greater scale the Amazon and Mississippi are doing now, and this especially on the sides toward the present continental plateaus, though the greater part must have been derived from the wide tracts of Laurentian land within the Arctic Circle or near to it.

It is further obvious that the ordinary reasoning respecting the necessity of continental areas in the present ocean-basins would actually oblige us to suppose that the whole of the oceans and continents had repeatedly changed places. This consideration opposes enormous physical difficulties to any theory of alternations of the oceanic and continental areas, except locally at their margins. I would, however, refer you for a more full discussion of these points to the address to be delivered to-morrow by the President of the Geological Section. But the permanence of the Atlantic depression does not exclude the idea of successive submergences of the continental plateaus and marginal slopes, alternating with periods of elevation, when the ocean retreated from the continents and contracted its limits. In this respect the Atlantic of to-day is much smaller than it was in those times when it spread widely over the continental plains and slopes, and much larger than it has been in times of continental elevation. This leads

us to the further consideration that, while the ocean-beds have been sinking, other areas have been better supported, and constitute the continental plateaus; and that it has been at or near the junctions of these sinking and rising areas that the thickest deposits of *détritus*, the most extensive foldings, and the greatest ejections of volcanic matter have occurred.

There has thus been a permanence of the position of the continents and oceans throughout geological time, but with many oscillations of these areas, producing submergences and emergences of the land. In this way we can reconcile the vast vicissitudes of the continental areas in different geological periods with that continuity of development from north to south and from the interiors to the margins, which is so marked a feature. We have for this reason to formulate another apparent geological paradox—namely, that while in one sense the continental and oceanic areas are permanent, in another they have been in continual movement. Nor does this view exclude extension of the continental borders or of chains of islands beyond their present limits at certain periods; and, indeed, the general principle already stated, that subsidence of the ocean-bed has produced elevation of the land, implies in earlier periods a shallower ocean and many possibilities as to volcanic islands and low continental margins creeping out into the sea; while it is also to be noted that there are, as already stated, bordering shelves, constituting shallows in the ocean, which at certain periods have emerged as land.

We are thus compelled to believe in the contemporaneous existence in all geological periods, except perhaps the earliest of them, of three distinct conditions of areas on the surface of the earth:

1. Oceanic areas of deep sea, which always continued to occupy in whole or in part the bed of the present ocean.

2. Continental plateaus and marginal shelves, existing as low flats or higher table-lands, liable to periodical submergence and emergence.

3. Lines of plication and folding, more especially along the borders of the oceans, forming elevated portions of land, rarely altogether submerged, and constantly affording the material of sedimentary accumulations, while they were also the seats of powerful volcanic ejections.

In the successive geological periods the continental plateaus when submerged, owing to their vast extent of warm and shallow sea, have been the great theatres of the development of marine life and of the deposition of organic limestones, and when elevated they have furnished the abodes of the noblest land faunas and floras. The mountain-belts, especially in the north, have been the refuge and stronghold of land life in periods of submergence, and the deep ocean-basins have been the perennial abodes of pelagic and abyssal creatures, and the refuge of multitudes of other marine animals and plants in times of continental elevation.

These general facts are full of importance with reference to the question of the succession of formations and of life in the geological history of the earth. So much time has been occupied with these general views that it would be impossible to trace the history of the Atlantic in detail through the ages of the Palæozoic, Mesozoic, and Tertiary. We may, however, shortly glance at the changes of the three kinds of surface already referred to.

The bed of the ocean seems to have remained, on the whole, abyssal, but there were probably periods when those shallow reaches of the Atlantic, which stretch across its most northern portion and partly separate it from the Arctic basin, presented connecting coasts or continuous chains of islands sufficient to permit animals and plants to pass over. At certain periods also there were not unlikely groups of volcanic islands, like the Azores, in the temperate or tropical Atlantic. More especially might this be the case in that early time when it was more like the present Pacific; and the line of the great volcanic belt of the Mediterranean, the mid-Atlantic banks, the Azores, and the West India islands point to the possibility of such partial connections. These were stepping-stones, so to speak, over which land organisms might cross, and some of these may be connected with the fabulous or prehistoric Atlantis.

[*To be continued.*]

SOME OUTLINES FROM THE HISTORY OF EDUCATION.

By W. R. BENEDICT,

PROFESSOR OF PSYCHOLOGY AND LOGIC IN THE UNIVERSITY OF CINCINNATI.

III.

THE truths of the educational reformers reached comparatively small circles. Everywhere the schools continued to turn out ministers and priests; indeed, this was the accepted design of the schools. We have many illustrations of the home training during these years. I name a few as recorded. Christian Weise, eight years of age, was required by his parents to discontinue study on account of sickness. He objected to this course, saying "The power of Jesus Christ will come to my aid, he who is strong in the sick ones." George Nitzsch (who wrote a treatise entitled "Is Scripture God Himself?") in his ninth year could find no more delightful occupation than prayer and memorizing sermons. Feustking, when he was nine years old, had read the Bible through five times, and at the same age had preached before his father's congregation. It is said that some one wished to use extracts from classical writers; the Church authorities thereupon

decided that the New Testament was written in the purest Attic Greek, and that any change was unnecessary.

We meet now a most instructive manifestation in the history of education. Formalism was blighting the Church, whether Catholic or Protestant; and blighting education, whether Jesuit or Lutheran. This formalism encountered an entirely new opposition, and all educational movement received a most peculiar shaping. Spirituality is the grace and life of some souls, as it is not the grace and life of some other souls. Never a church or party so bad as to contain no spiritually-minded. These are they who now appear, materially affecting the course and method of education. We should see clearly the position of affairs. Speaking historically, there are two oppositions to scholastic orthodoxy in education: one, the realistic, basing itself upon an experimental philosophy, and eventually working itself out as a scientific method; the other, spiritualistic, basing itself upon the purely spiritual elements of our nature, and developing into mysticism, pietism, and all vagary. There is a singularly interesting comparison between these different attacks upon scholastic orthodoxy. We have seen how the experimental philosophy received form and power from Bacon; we have seen how Comenius applied this philosophy to education; yet we know that education was not rescued from scholasticism. The reason, as I believe, lies in this fact: A purely or even a largely intellectual opposition was not able to reach the emotions and the conscience, and, until these were profoundly stirred, there would be no true, permanent deliverance from scholastic orthodoxy. A protest must arise from the side of the feeling. Precisely this did arise, precisely such an opposition manifested itself within both churches, appearing as Jansenism with the Catholics and pietism with the Protestants. This emotional protest, this protest in the Church herself against herself, brought clearly to view the radical antagonism between scholastic training and the newer methods everywhere appearing.

Jansen, born 1585 in North Holland, found the fundamental evil of his time to consist in the exclusive occupation of men with heathen philosophy—i. e., with Aristotelian scholastic. He made a thorough separation between philosophy and theology, believing them to rest upon widely different bases. This Jansenist movement in the Catholic Church was applied to education by the society at Port Royal. The most celebrated representatives of the method are Rollin and Fénelon. A sentence or two from Rollin will show his position: "I know that the true purpose of the teacher is not merely to make the scholars acquainted with Greek and Latin, or to teach them to write verses and exercises, or to burden their memory with events and dates from history, or to enable them to shape their conclusions in correct form, or to draw lines and figures upon paper. I do not deny that these studies are useful and worthy all praise, but only as means not as end, only when they serve as preparations to better things." Rollin is

plainly a humanist. In his opinion a study of the languages is most important as an introduction to all knowledge. As respects the methods of learning these languages Rollin directly opposes scholasticism and appeals to Nature. He is right in this, for, if Latin and Greek are to be taught at all, they are to be taught *naturally;* and if those who advocate classical training as an essential part of every student's education would do *permanent* work for their conviction, let them present these languages *naturally* and *philosophically.* The opposition to formalism based upon the spiritual nature was universal, and produced similar results in many lands. It was known among the Catholics as Jansenism in the Netherlands and France, as Quietism in Italy and Spain. It was known among the Protestants as Mysticism and Pietism in Germany. The Protestant German representatives of this reaction are Böhm, Spener, and Zinzendorf. A few lines from the first of these men show the nature of mysticism and its relation to education. Böhm writes: "Man is the image, life, and being, of the uncaused God. In man's body is all Nature concentrated. The soul is the outspoken word, as the power and understanding of all being, as the revelation of Divine Reason. Man stands in the outward world and bears in himself heaven and hell. As the spirit of eternity has imaged all things, so the human spirit bodies itself forth in word, for everything originates from one center. If I read myself, I read God's book. We know Nature, because we stand in her and have her in ourselves. We know God, because he is in us and we live in him. God himself is our seeing and knowing—from God's seeing has sprung my seeing."

Such thorough-going opinion would not tolerate the faults of a dead and formal training. Böhm saw the error from his point of view, and hesitated not to speak: "The small boy who runs about in play is full of the poison and iniquity of the devil, and all forms of vice inhere in him. He is a mocker, a swearer, thoroughly prepared to serve the devil in all his deeds. The shamelessness is the Latin on his tongue. He knows how to imitate all the jesting words of the ancients. The youth mock without consideration. Whoso fears God must be their fool and jest. Their parents see these youth, and rejoice that the boys are so skillful in their rascality." Mysticism, Quietism, Pietism, are differing names for one and the same protest made by the spirit against the letter. Since there never was a time in the history of Protestantism when so direct an attempt was made to conduct education according to the religious spirit, it may be wise to give this matter more thorough consideration. Pietism may be said to have been established by Philip Jacob Spener, born at Rappoltsweiler in Elsass, 1635. We shall, as I think, best recognize his spirit and method by the following sentences from his writings: "Before all things we should hold fast the fundamental truth that Christianity does not show itself in *knowledge* but in *practice*, and that the Christians must be led to

works of unselfish love, to the control of their spirits under slander, to the withholding of themselves from all revenge, to love and patience even in theological matters. Our fathers, with praiseworthy anxiety, established schools; they did so that, in these schools, the youth might not simply be built up to manhood, but especially that they might be led by pious training to a living knowledge of their Father; that the image of God might be more and more perfected in them, that from these schools men should go forth, not simply for the spread of knowledge, but that, equipped with every virtue which leads to true happiness, they might serve the honor of God and the public good in the position to which God had appointed them. As it now is, all industry in the schools is given to Latium, so that little remains for Hellas, for Judea scarcely anything. Our youth go from the schools tolerably well furnished with such knowledge as they shall put to outward use, but without knowing God, all absorbed in love for the world and endeavor to please it, wise for themselves, but so much the less instructed in divine wisdom."

We must clearly know what pietism, at its best estate, proposed as the end of education. We shall, I think, find this end distinctly set forth in the following utterances:

"The final purpose of all education is a living recognition of God and an upright Christian deportment. Only the genuinely pious man is a good citizen of society. Without true piety, all knowledge, all skill, all world-culture, are more harmful than useful, and man is never safe from the misuse of knowledge. First, and before all other things, education must strive for the radical improvement of the heart. Everything which immediately or mediately works against this supreme and final end must be banished. *Instruction is subordinated to training.*" (Italics the present writer's.) "The purpose of the school is not an impartation of certain knowledges—*all* teaching must contain an *educative* tendency. The design of such training is the upbuilding of the kingdom of God in the heart of the child, and, proceeding from this basis, education should be comprehended in all its grades and divisions as one system, one culture. Those who give themselves to study should regard the ancient languages as the chief concern. Latin is to be pursued the most, and grammatically, from the beginning. Greek has its basis in the New Testament. A chief advantage to be gained from the ancient languages is a right understanding of the sacred Scriptures, which every student should read in the original. It is well to understand the heathen writers; still, too much occupation with them easily leads away from a high estimation of the Bible. Next to the languages, no student should remain unacquainted with geography, mathematics, history, astronomy, and natural philosophy. In the higher classes logic, which leads to orderly thought, and rhetoric, which leads to correct and good expression, should be pursued and made practical by exercises and disputations."

Referring, again, to the spirit in which education should be conducted, Spener asks: "To what does all the striving of the professors tend but to fill out the brain with theological philosophy, or a human skill in holy things, while their hearts are void of all true heavenly influences? The anxiety of the far-seeing Erasmus is but too fully realized, for he testified that his joy over the widely increasing application to study was diminished by the fear that much heathenism would steal in upon the spirit."

With the general endeavor expressed in these words a large proportion of educators from all sects and parties would agree. That education should strive for the radical improvement of the heart, that the purpose of the school as such, i. e., from first to last, is not merely the impartation of certain knowledges, that all teaching must contain an *educative* tendency—these are propositions which commend themselves to all who have had direct relations with the young in their years of development. It is well known, however, that many are honestly disposed to go much further than this. It is the conviction of a large number of our people that education must never be allowed to become godless; that each institution of learning should make it an essential part of its business to inculcate the fundamentals of religion. It is the reiterated assertion of one of the most powerful church organizations to be found in history, that our schools are without God, and so permit the young of both sexes to grow up uninstructed in the essential truths of a right life. The history of education teaches some plain and weighty lessons respecting this present matter. The pietistic movement originated naturally and justly. It was the full protest of the spiritual nature against formalism. It recognized something better than knowledge, and it sought to furnish this higher truth. Its position was exactly that of many sincere minds to-day who feel dissatisfied with the education of any young man or woman that consists of knowledge alone, being without the informing spirit that leads to nobility of character.

What did pietism accomplish? *It brought the schools back to every-day life.* Applying catechetical instruction to the children, and regarding all education as designed to nourish a spirit of piety, these protestants against formalism drew education out into general view and common life. The schools were regarded as an organic whole, whose basis was the common school; and, further, the entire school system was placed in most intimate relations with the home — the school-training being required to be supplemented by home-culture. These principles spread over Protestant Germany; schools for the poor and orphan-schools were established in great number. We ask what came from this attempt to conduct education in the religious spirit? Our answer is, a most lamentable extreme—a serious and thorough failure. As if in very mockery, the protestants against formalism became diseased with formality. Pietism became the letter that

killeth. Here was the principle which worked all mischief. Let man keep himself from everything not avowedly and directly religious. The application of this principle separated man more and more from real life, and, in the place of that very spirit to be brought out and cherished, there was left to these schools of the pietists a vicious form. The outward posture became the essential thing. A spiritual police system was introduced, all schools and families were constantly searched in quest of the chief means of instruction—the Bible and the catechism. It came to be believed that the young people, if left to themselves, would go to destruction. Accordingly, the pupils were never left alone, not even for a moment; exercises for worship were multiplied, praying and preaching never ceased. Here was an educational system originated to develop true piety, and actually producing lying, hypocrisy, and contemptible Phariseeism. Here was an educational system designed in the interests of spirituality, and at the same time working a twofold evil—crushing out in weaker natures all fresh, individual life-power; repressing in stronger natures those passions which fed upon themselves for the years of school-life only to break forth at last with destructive fury.

We may realize the fearful state to which pietism came by noting the condition of the orphan-schools and poor-schools. These houses were originally the result of Christian sympathy; they became "instruments for a kind of soul-cure." The prayers of the orphans were solicited and published on the doors of the buildings. "Four groschen to pray for a man with bad eyes." "One groschen to be freed from the toothache." "Eight groschen, pray God, dear orphans, on account of my sinful thoughts." "Four groschen that God may send me belief on the Son of God." Spener did not recognize the truth he proclaimed—he was never entirely free from the formalism he opposed. He felt the deadness of the Church, and at the same time believed that salvation was necessarily bound up with certain forms of dogmatical teaching. He desired a true and living piety, but did not believe this was anywise possible except for those who accepted, without question, the visible, literal form of faith. Piety, thus confined, could not develop otherwise than as it did with Spener and his associates. This striking movement in the history of education and its disastrous outcome might well lead the thoughtful mind to inquire whether religion is a matter that can be taught. It may lie in the very nature of this subject that it can not be communicated from the professorial chair, however wonderfully endowed. Upon the supposition (an hypothesis far beyond the territory of hope) that all educators could agree as to what make up the fundamentals of religion, it might be found that the best, the *only*, method of imparting them would be *by example*, by a deportment sincerely in harmony with them.*

* See, in this connection, that delightful little work, "An Attic Philosopher," by Émile Souvestre.

Reference has been made in these papers to a third general cause contributing to the rescue of education from middle-age formalism. This third cause was "discovery," that is, actual increase of knowledge in various domains. This enlarged knowledge was, for the most part, of a physical character; it had reference to the visible, measurable phenomena of Nature. There lay wrapped up in the wonderful advancements of the eighteenth century both bane and blessing. Society, as representing the external relations of men with one another, was immeasurably benefited. Civilization, as we now know it, received power to become only through the magnificent discernment of natural laws which, beginning in the earlier part of the eighteenth century, has proceeded with sure course to our own time. Health and wealth and all physical comforts were secured for men as never before by manifold scientific discoveries. We should go even further than this and recognize the relation which obtains between man's physical and his intellectual and moral well-being. To increase man's healthfulness is to make possible an increase in his intellectual and moral nature. An almost immeasurable amount of ignorance and vice must be attributed to bodily disease and untoward physical surroundings. To purify the air which man breathes and the food which he eats is to take the first steps for his culture and his salvation. All gratitude, then, for the work which has been done, and is now doing, to improve man's physical condition! Such work is organically connected with whatsoever is truly progressive in intellect, morality, and religion.

I have said that there was evil in the course of this movement in the eighteenth century which we are now considering. *Denial, or rather that doubtful mind which is essential to the attainment of truth, became an end and afforded pleasure.* No evil that can befall man is greater than the evil of *loving to deny.* This evil began its course in English deism, went on to fuller manifestation in the admirers of Voltaire, and found its completion in D'Holbach and Büchner. Let not this statement be misunderstood. Men are sick, and know not the disease which afflicts them. Disease is often concealed in its development along the line of generations. The father appears rational and well, the poisoned child becomes demented and dies. History is, as it were, the life of one man prolonged; whatsoever lies in this life finds time for development and full manifestation. English deism was an expression of the critical spirit in England. Whence did this spirit receive its peculiar power? From the deaths of persecuted seekers after truth. Here and there a man searched till he found. When he spoke, they slew him in the name of God and the Church. The age of discovery was come, and the instrument for the work was none other than this same critical spirit, the spirit which would test, which would inquire of Nature until she answered. Who should restrain this spirit, or withhold its manifold applications? When Tyndale and Shaftesbury, applying it to religion, resolved all creeds into one formula of

five short phrases, who should hinder? When D'Holbach, in France, and Büchner, in Germany, applying the same spirit to the supposed elementary principles of intellect and morality, resolved these also into movements among the brain-particles, who should hinder? No one should hinder either deism or materialism, if it but leads to the truth, to the real. What shall we say if the instrument come to be loved more than the truth it was designed to make known? What if denial become precious *for its own sake?* Here is calamity enough. Here is the extreme;—from credulity to incredulity—from omnivorous belief to omnivorous denial. That there lay in the eighteenth-century development both English deism and French sensualism is no more to constitute a final condemnation of scientific discovery than the monstrosities done in religion's name should be alowed to sweep away the beauties of a pure faith. When one concludes from inquisitions and witch-burnings that there is only evil in Christianity, it is as though he should deny all worth to science because of the critical spirit and its monstrosity, a *love of denial.*

English deism was applied to education in Defoe's remarkable book "Robinson Crusoe." Man is to be educated *according to Nature,* rather should we say *by* Nature.

The contrast is sharp between the natural method of Comenius and this new appeal to Nature. Here society, school-systems, books, were to have no place. To Nature, as a sort of divine person, the child was surrendered for education. It was supposed that Nature would bring out the universal traits of mind, the universal religious ideas, the universal social laws. We find here a most instructive illustration of the tendency, so universal in human thinking, to personify our abstractions. Words such as nature, justice, virtue, law, are used by us to represent some independent entity or being. This ineradicable habit has been the source of desperate evils in all directions. We have now before us its application in education. We are told to follow Nature. This Nature, be it understood, is an all-wise being, independent of our activities, able to guide us with a perfect wisdom. Such was the phase through which education must pass before the true method of following Nature could appear. The sharply contrasted lines of training, now known as the scientific and the classical, are being differentiated at the time of which we write. More than this, if we look closely we shall find here a reason in history for regarding the scientific training as pre-eminently natural, as pre-eminently obedient to the command "Follow Nature."

The critical spirit, applied to education, received brilliant expression in France and serious testing in Germany. I state some of the fundamental principles of Rousseau's "Émile": "Everything is good as it proceeds from the hand of the Creator, everything deteriorates in the hands of man. We are educated by Nature, by men, by things. The child should be educated for a common human calling, not for a

special position. No mother, no child. Follow Nature. All the mischief of children comes from weakness; make the child strong, and it will be good. Educators render children miserable in that they take the presence of childhood for nothing, and keep in their eye only the future of the child which it may never reach. See in the child only the child. Before the child reaches understanding, it must be thrown entirely upon the physical world. Therefore, you should not begin to reason too early with children. The first education should be purely negative: it consists not in teaching distinctions between virtue and vice, but in keeping the heart from faults, the understanding from errors. The only moral instruction for children is to do nobody any evil. Instruction should begin with things. At twelve years of age sense-impressions should be built up to conceptions. No other book should be used than the world, no other instruction than facts. The secret of education is so to arrange it that bodily and spiritual exercises are reciprocally helpful. At the fifteenth year of his life Émile appears in this wise cultivated. Obliged to learn by himself, he uses his own, not another man's understanding, and he puts forth nothing on authority. Émile has, to be sure, little but no half knowledge. He knows there is much he does not know. He has only knowledge of Nature—nothing historical; about metaphysics and morality he knows nothing. What death is, he knows not; but accustomed, without resistance, to surrender himself to the law of necessity, he will die, when he must, without a sigh. His body is sound, his limbs are sure, his understanding right and without prejudice, his heart free and without passions. Thus is Émile at fifteen years of age.

"But man is not created to remain a child. He steps out of this condition at Nature's appointed time. His physiognomy changes and gains expression. The voice changes. The eyes, those mirrors of the soul, that hitherto have said nothing, receive language and meaning; an increasing fire animates them, their glances are living. He feels without knowing what he feels. He is restless without cause. Be upon thy guard. Not one moment from the rudder, or all is lost! Now is the man really born to life, and nothing human is foreign to him. Hitherto our anxiety has been but a child's play; now it begins to be a great weight. This time, when generally education is ended, is the very time when ours shall truly commence. Now Émile is to become acquainted with his own kind. This is the period for history. To know men, you must see them act. In intercourse with the world you only hear men speak—they show their words, but conceal their deeds. In history they are unveiled, and we are able to judge. But Émile shall judge them himself—only thus can he gather knowledge of mankind. If the author's opinion continually lead him, he sees through another's glass, and when this fails he sees nothing at all. He shall see with his own eyes, feel with his own heart; no authority shall control him save the authority of his reason. But now

he must be led into the world of religion. Brought up as he has been by the sense-world, the abstract scarcely finds entrance. God withdraws himself from our senses. The word Spirit has meaning only for the philosophers. In his fifteenth year Émile does not know whether he has a soul or not. If I wished to represent stupidity symbolically, I would paint a pedant teaching children out of a catechism. They say a child should be reared in the religion of his father, and prove this is the only true one, the others absurd. But suppose the strength of the argument depends upon the district where they use it, or upon authority, to which Émile pays no attention. How then? In what religion shall we educate him? The answer is plain —in none. We will place him in condition to choose that which the best use of his reason may approve."

The time, the thought, and the style of Rousseau's "Émile" combined to make it the most powerful word yet spoken for the true development of education. "It was a vigorous blow against the science of mere words, against the pitiable omniscience of children, against books as means of instruction. Never before had the natural methods for education been so forcibly thrust into the places of the miserable middle-age apparatus."

We need not delay for any extended criticism of Rousseau's thought. Its radical deficiency has been often stated and acknowledged. We phrased it as the personification of an abstraction. Believing in the total degeneration of humanity, believing that there was nothing natural in the historic development, Rousseau would call men back to Nature. How back to Nature? *Where was Nature?* Not in society—in Rousseau? Certainly here, if anywhere, and with this the entire thought fails, so far as respects its efficiency for a scientific principle in education. Émile, separated from his unnatural fellow-beings, must be guarded against the possibility of doing as they did; and yet he must be taught *according to Nature.* Rousseau was all the nature Émile could have, and he would be educated naturally, therefore, only so far as Rousseau corresponded to Nature.

To break away from artificial restraints and to find Nature has fascinated men from earliest times. One of the most beautiful illustrations of this impossible undertaking is the Arabian romance, "Hai Ebn Yokdahn" ("The Nature-Man"). This was written by Tophail, who died in the year 1190, and is mentioned here merely as a reference for those specially interested in these endeavors.

It is among the Germans that we find a serious attempt to apply the new ideas to the actual work of instruction. The philanthropists attempted to realize the educational ideas of Rousseau. Their leading principles, both negative and positive, are as follows: "The universal condition of the world is infinitely bad. Church and state, school and family, are marked by folly and wickedness. Above all, the school is thoroughly defective in its very foundation. Every-

where uncomprehended words are learned *verbatim*, school-dust lies hundreds of years thick on the natural method of teaching languages; every one who breathes this dust is sick in the brain. Instruction carries everywhere the marks of the time when the schools were established. Young people are taught a multitude of things of which they make no use in all their life.

"A *new foundation* must be laid upon which a new species can develop, since a regeneration can not be thought of while the youth are not transplanted to a new ground."

We note a few of the affirmative propositions: "Artists must be trained if art is to prosper. In physical education we must return to the method of the ancients.

"The will must be governed by the reason. During youth religion shall be taught only in its extreme simplicity, without attention to sects or parties. We should not repress the natural tendency to freedom, but guide it. Children are by nature good—compulsion renders them bad.

"The boy who has no sense for anything abstract and incomprehensible, least of all for the ordinary catechism, should, before anything else, be made acquainted with the sense-world. This can be shown to him in Nature and by pictures.

"The youth are troubled with nothing so much as with Latin. More than five years are given simply to the learning of Latin. Yet there is not a fourth of the pupils thus taught who can read Latin books without trouble or without mistakes. When these hindrances are removed, the true aim of education will be reached. This aim is to form Europeans, people having such habits and manners as are common in all Europe, people whose life should be free from harmfulness, as universally useful and contented as they might become through education."

Kant, born April 22, 1724, expressed his opinion very forcibly as to the needs of the schools at this time: "In the civilized lands of Europe educational institutions are not lacking, neither is there lacking, on the part of the teachers, a well-intentioned industry. Still, it has been clearly shown that these institutions are worthless, and that, since *everything in them works contrary to Nature*, they fall far short of bringing out of men the good for which Nature has given the material. We should see quite different men around us if those educational methods came into force which are really drawn out of Nature, and not those which are but slavish imitations of the ancient customs of rude and inexperienced ages. The solicitude of the common people of all lands should now be directed to the establishment of such a master-school. This institution is no longer a merely beautiful idea, but now shows, by visible proofs, the practicability of what has been so long desired. The public repute, and pre-eminently the united voices of scientific and discerning judges from varied lands, have

marked the Dessau Educational Institute as the one that displays the evidences of excellence."

Kant's commendatory words refer to the School of the Philanthropists, founded December 27, 1774, at Dessau, under the direction of Basedow. This reformer represented Comenius and Rousseau. A few sentences from his writings are significant in this connection:

"The great aim of education should be to prepare the youth for a *useful, patriotic, and happy life.* Instruction should be rendered as agreeable as is consistent with its nature. Practice in the memory of *things* is far more important than in the memory of *words.*

"But this knowledge of things must furnish new representations to the understanding; must not simply fill out the memory with words. Paintings and engravings are of great service in instruction. Experience teaches how everything which resembles a picture pleases children."

A public examination of Basedow's work was held in May, 1776. The reformer's invitation contained the following passage: "This affair is not Catholic, Lutheran, or Reformed, but Christian. We are philanthropists, cosmopolitans. Russia's or Denmark's sovereignty is not, in our teachings, placed after Switzerland's freedom. Our textbooks are free from theological bias for the Christian as against Jews, Mohammedans, deists, or the dissenters, called, in some places, heretics. Very little memorizing is done by us. The students are not forced to be industrious. Still, we promise by the excellence of our method of instruction, and by its agreement with all philanthropic education, twofold as much progress as can be secured by the best schools or gymnasia." The public examination was favorable, and many influential men approved the undertaking in highest terms. There were bitter enemies, however. Most of the directors of the gymnasia opposed Basedow to the utmost, and Herder expressed a feeling more or less prevalent when he wrote: "The whole thing appears to me horrible. They tell of a new method for raising oak-forests in ten years. I wouldn't give Basedow calves to raise, much less men!"

We have considered a slow and complex movement, yet one steadily tending to definite result. The movement has been away from classical training as a *necessary part of education.* Montaigne, Bacon, Ratich, Comenius, the pietists, the philanthropists, have led education into new courses. The tendency was clearly revealed in the Dessau Institute. Education has been emancipated from scholasticism, and this with such force as to threaten the future supremacy of Greece and Rome.

As matter of fact, we have now before us, in the historical development of our subject, two sharply contrasted ideas. Whether these ideas are necessarily antagonistic is not the present question. We are concerned with the forces actually at work, and with the manner of

their unfolding. Those who favor and those who oppose classical study as a *necessary* part of education can justify their position by an appeal to one or the other of the ideas about to be stated. All questions as to disciplinary benefit, as to method of instruction, as to amount of net result, are wholly out of date. The changes could be rung forever on these matters, with no gain and much loss of temper. Most of the claims put forth by those who advocate the superiority of classical studies are either nonsense or beside the mark. Classical studies *have* advantages—that is to say, excellences—*peculiar to themselves. So have the sciences.* These different advantages will appeal to different minds, and no power can prevent the appeal. Let each party so teach as to bring out the advantages *best*, in fullest manner. If the history of education shows anything, it shows that the place for *all* efficient reform in education is in the *manner* of teaching rather than the *matter*. Devising something new to be learned will never save the soul; devising, or rather finding, the right *way* to impart knowledge *will* save, and this with a growing salvation.

If the professors of Latin and Greek recognize that they are not solely or chiefly professors of philology—but rather that they are appointed to acquaint the scholar with *literatures* transcendent in their beauty of form, their wealth of imagery, and their depth of thought—if the professors of Latin and Greek recognize the true method of doing this great work, classical study will never be neglected. All this is equally true of the instructors in physical science. The distinction between a fact seen in the dry light of its naked isolation and the same fact as part of an organic and amazing whole is the distinction between life and death in the teaching of science.

To employ a certain kind of teaching (which is in *no sense* teaching), and to expect educational reform by confining a boy to physical science or to classics, is a colossal mistake. To pay the lowest wages in the primary grades of our schools, where the best teaching is imperatively needed, is an equally impressive blunder. To engage a professor for *what* he knows, for the number of books he has written, for the amount of original work he has done, is—to do a grand thing for the professor, but by no means necessarily a grand thing for the pupil. Most of the young men and women in American colleges *need to be taught.* Is this to decry research or the establishment of all means for discovery? Rather is it to discriminate between the work of teaching and the work of investigation. Is a man called to teach, is he employed to teach, is he paid to teach—let him, then, teach, i. e., let him spend himself in the work of education. Were every teacher, nay, were the majority of teachers, to see in the pupil the pupil, there would be a reforming of education such as has not yet been experienced.

We close this paper by such a brief statement of the opposing ideas previously mentioned as may best serve to show their reality.

Fortunately, our purpose has been already served by a few contrasting paragraphs admirably conceived and expressed :

I. "From the standpoint of humanism education has its own purpose *in itself*, viz., universal culture of man. According to philanthropism, education has *not* its purpose in itself, but only a *relative* purpose, viz., the training of man for a future avocation.

II. "From the point of view of humanism it is not, in education, so much matter of chief importance to *collect knowledge* as to discipline the spirit by it. From the point of view of philanthropism, the aim is to fill the mind with the largest possible amount of useful information.

III. "Humanism exercises the mind of the student not so much to make him apt for some appointed business—*culture of the spirit is here an end in itself*. With philanthropism culture is something aimless in so far as the spirit is not made more apt by it for some special business.

IV. "As respects the objects of education, humanism does not require many objects by which the youth is distracted and prevented from thorough acquisition. The pupil should be advanced by a few objects to the highest degree of knowledge.

"Philanthropism, on the other hand, in view of the daily increasing territory of what may be known, does not dare confine itself to holding the youth throughout his entire period of education to a few objects—much rather attention should be paid to rendering easy the circle of objects, that the child may be offered the greatest possible amount of knowledge.

V. "Humanism brings before the youth single departments of knowledge in the *entire manifoldness of their separate objects*, then teaches to arrange these objects with *exact system*, thereby to accustom the student to logical thinking, so that, when later he ventures upon outlying territories of knowledge, he will not fall into error. Philanthropism would broaden instruction, to cover as far as possible the entire field of knowledge, because he who has not a view of the whole must possess only half-way and distorted impressions concerning the separate departments of knowledge and their particular objects.

VI. "According to humanism, not *things* but *ideas* are best adapted to the exercise of the spirit, that the youth may not, during his future, active life lose himself in the region of bread-and-butter knowledge. Philanthropism demands for this very mental exercise not ideas (which strictly considered are only words), but *things*, and this in order that the mind, perpetually occupied with letters and words empty of content, may not lose itself in the region of mere word-knowledge, and become good for nothing in practical life."

These ideas of man and of his place in the world are fundamentally distinct. They can never be done away or disregarded, for they root themselves in the twofold nature of man. It is possible to be a hu-

manist or a philanthropist in education both with sincerity and with reason. There is a seed of truth in each half of these contrasts, and it is more than probable that, despite all attempts at adjustment, men will be born humanists and philanthropists to the end of time.*

COMTE AND SPENCER ON SOCIOLOGY.†

By LEON METCHNIKOFF.

THE most momentous intellectual conquest of our days is, perhaps, the discovery of the great law of the unity and continuity of life, generally styled the law of evolution. Not only are the remotest branches of knowledge—as, e. g., physics and psychology, or chemistry and politics—connected by it into a systematic and harmonious whole; but by it also has been realized that union between science and philosophy for which the clearest minds of former ages longed in vain. The secular feud between idealists and materialists ceases on the solid ground of the evolutionary doctrine, where every science becomes philosophical without surrendering to any metaphysical or *a priori* conception; while, on the other hand, our psychological and ethical inquiries acquire a firm basis and scientific precision and accuracy as soon as they are touched by the vivifying spirit of this theory.

Since we admit the unity of life, and since we consider cosmic phenomena, in spite of their amazing apparent diversity, only as various manifestations or consecutive degrees of one evolution, we are compelled to infer that our methods of political or historical knowledge ought to be essentially identical with those generally prevailing in physical or biological researches. Metaphysical speculations on social matters, in which the greatest philosophers of former centuries delighted, lose their hold upon the skeptical mind of our age, and even the economic empiricism of Adam Smith, Malthus, and Ricardo, grows inadequate to the modern demand for positive knowledge of the natural laws pervading the evolution of human societies. Sociology, i. e., a strictly scientific statement of these laws, is considered nowadays as an integral part, as the necessary "*couronnement de l'édifice*" of a methodical conception of the world. The very name of sociology has been created *ad hoc* by Comte, who esteemed himself to be the

* In closing the more distinctly historical portions of these articles, I desire again to express my indebtedness to the foreign histories of education. From such a work as Schmidt's "Geschichte" I have made selection and condensation as seemed best to serve my purpose.

It will be understood that for all criticisms and opinions, e. g., on English deism, on classical study, I am alone responsible.

† From an article entitled "Revolution and Evolution," in the "Contemporary Review" for September, 1886.

founder of that *Novum Organum* or gospel of modern intellectual regeneration.

In his classification of sciences, based upon their increasing concreteness and speciality, he states that science, though essentially one in opposition to metaphysics and theology, ought to be divided into branches, or sciences in a more restricted acceptation of the word, each of them corresponding to a well-defined series, the number of which he fixed at six, as follows: first, Mathematics; second, Astronomy; third, Physics; fourth, Chemistry; fifth, Biology; and sixth, Sociology.

Without insisting upon the number of these divisions or their philosophic value, I shall only consider the limits of sociology as they have been traced by the master-hand of the French patriarch of that strange mixture of knowledge and faith ("Catholicism *minus* Christ and *plus* erudition," as it has been styled), which still holds sway over so many minds under the name of the Positive Philosophy, and the peculiarities of which are partly due to the depressed state of his health at the time when he wrote his most important sociological works, and partly, perhaps, to his native pedagogic whims.

According to Comte, sociology ought to be a science, so to speak, exclusively human. Social facts may be common in the life of animals, and even of plants, but he entreats the sociologists of his school not to pay them any attention. While other sciences are cultivated for the sake of truth, Comte would have sociology to be learned only for the sake of human morality. As to the methods of sociological research, he admitted them in his first writings to be similar to the strictly scientific methods of observation and induction, but he soon retracted that admission, and declared that skeptical analysis ought not to enter the sacred precincts, synthesis alone being worthy of such elevated study. Thus he voluntarily created an abyss between science and sociology.

Referring to the limits and object of sociology, the statements of the great founder of the French positive philosophy appear, in certain respects, far more worthy of acceptance. Selecting, arbitrarily, the human individual as the starting-point of his researches, he observes that one part only of our activity is based upon egoistic instincts arising from need of nutrition or personal preservation in general; that part, including our uppermost psychological recesses, belongs to the biological domain. Sociology includes the remainder—viz., that part of human activity which is based not upon individual self-satisfaction, but upon what he calls *altruistic* instincts, supposing them to be inherent in every living being. The physiological roots of *altruism* he perceives in the sexual attraction, the natural result of which is the *association* of a male and a female for the preservation of species—an end not personal to either of them.

A psychologist would observe, first, that Comte uses the word "in-

stinct" in a sense which is not very clear and is throughout unscientific; for, according to modern researches,* we do "*instinctively*," i. e., unconsciously, that which previously we did knowingly, and thus to account for an "instinct" as a *primum movens* sounds somewhat like the "purgative force of the rhubarb"; secondly, that the distinction he makes between egoistic and altruistic instincts is superficial. From the subjective point of view, it is obvious that whether they act under the impulse of sexual attraction or under that of hunger, individuals aim merely at the satisfaction of physiological (egoistic) want; nor are their objective results so essentially different as Comte pretends; hunger as well as sexual attraction is able to lead men and animals—in some cases to struggle, in others to *co-operation*. And, if he did not exclude the social life of animals from the field of his humanitarian sociology, he might easily perceive that associations for food or for self-defense have generally a far more social character than primitive conjugal alliances for progeny.

Nevertheless, the greatest, perhaps the only valuable, service rendered by Comte to social science lay in the very clear distinction he made between the sociological and the biological domains, when he referred to sociology only such aggregation of individuals as is based on *co-operation*, conscious or unconscious, and abandoned groupings based on struggle to biology. Thus, I may say, he opened the door of true social science without himself entering its precincts, and, unfortunately, I must add, misleading his followers with his erroneous statements as to the unavoidable subjectivity of the methods of social knowledge. I insist upon that high service; that remarkable definition of the boundaries and of the object of sociology appears, so to say, drowned amid the numberless quaintnesses of his whole system, and none of his admirers, orthodox or schismatic, have ever cared so far as to disengage from his hardly readable volumes the few lines.

Owing to his restricted acknowledgment of the principle of the unity of Nature, Comte appears, at any rate, scarcely a precursor of the modern scientific evolutionism. Looking for a more complete and methodical compendium of that theory, we have to cross the Channel and to approach Herbert Spencer's "First Principles," and his many other valuable essays on ethical, political, and other sociological subjects. No mind could perceive more perspicuously than Herbert Spencer does the admirable unity of Nature, and no pen could describe it with half so much clearness and attraction as his. While the science of Comte, always behind his age, appears like a mosaic of six stray pieces—and the author takes painful heed to make us feel the gaps which he supposes really to exist between them—the science of Spencer on more than one point gets the start of the erudition of modern specialists, and is throughout livingly and harmoniously one, according to the unity of Nature.

* Romanes, various writings; also A. Herzen, "Studii fisiologici sopra la volontà."

In the system of Spencer, as in that of Comte, sociology appears at the top of the scientific series, but with him this pinnacle of knowledge is really and solidly connected with the building itself. In spite of their much greater complexity, social phenomena are essentially identical with those of inferior cosmic life. Sociology for Herbert Spencer is a physical science like others, requiring no peculiar synthetic or subjective methods, and its aim with him can not be any other than the reduction of the specific laws of social life to the universal laws of motion.

Passing to the delimitation of the sociological domain and to the definition of the object of that science by Herbert Spencer, I must observe that those matters, in modern evolutionism, present a degree of complication which Comte avoided by the artificial isolation he created for sociology in his philosophical system. Natural science teaches us that association is the law of every existence. What we usually call society in common speech is only a particular case of that general law. A being, whether social or not, is never absolute, indivisible; but essentially comparative and multiple, resulting from the action of a number of forces converging on one point.

Political and social systems speak a good deal about "individual" and "society"; but the very point where the individual ends and society begins has never yet been fixed with any accuracy. The most prominent botanists and zoölogists, who have to deal with this matter for their own technical purposes, have been led to acknowledge several degrees of individuality: we can consider each individual as a whole, or a person, in comparison with the individuals of a degree beneath it; but when we compare it with the individuality of a superior degree, it soon loses its personality and appears as a part, a member, or an organ. There are myriads of plants (*algæ*) and animals (*infusoriæ*), which are styled monocellules, and which, indeed, are considered as consisting of one single organic element or cell, although their anatomical structure appears, sometimes, very complex and perfect in its peculiar style. But organic cells quite identical with these form also aggregations, or associations, more or less compound; and such groups of cells either live independently, unfolding their own botanical or zoloögical individuality, or enter, in the shape of textures and organs, into the composition of other still superior individual beings. Men, like other *mammalia*, are, in fact, associations of such colonies of cells. Our inveterate tendency to consider ourselves as an end and a center of the creation makes us prone to prejudge that our own individuality is the only genuine one.

It would be hardly possible to review in a few lines the remarkable researches into the various degrees of vegetable and animal individuality of Nägeli, Virchow, Huxley, Haeckel, and many others; and it is beyond my competence to settle whether absolute individuality, i. e., morphological indivisibility, ought to be granted to cells—as was as-

serted till the last few years by the most authoritative scholars—or whether organic cells themselves consist of individualized elements (*plastids*) still more primordial. But that is not intimately connected with the main object of the present essay, and the biologists are now somewhat at variance on the point. I shall only observe that the great De Candolle distinguished six degrees of individuality in plants alone; Schleiden reduced that number to three (the cell, the shoot, the *cormus* or stock); while Haeckel, again, doubled that number. For shortness' sake, we may admit the classification very recently (in 1883) proposed by a young Italian scholar, M. Cattaneo,* who, considering the question from a zoölogical point of view, fixed the number of such degrees of individuality at four, as follows: 1. *Plastids*, i. e., cells or any other primordial elements, after dividing which we should get not a being of any kind, but mere amorphic organic matter; 2. *Merids*, i. e., colonies of such plastids; 3. *Zoïds*, i. e., such individuals as are autonomous so far as their individual preservation is concerned, but which are obliged to unite with other individuals of the same series for preservation of species (like superior animals and men); and, 4. *Dems*, i. e., colonies of zoïds: conjugal couples or pairs, families, tribes, societies.

Assuming that the proper aim of sociology is the investigation of the natural laws regulating the connections between individuals and society, it is obvious that, before we approach sociological studies themselves, we must answer the preliminary question, Which of the various degrees of individuality above mentioned we accept as the starting-point of our researches; or, in other terms, where ought the domain of social science properly to begin?

For Comte social life begins as soon as two individuals of the series of *zoïds* (he explicitly says, man and woman) unite themselves in a conjugal pair, the result of which union is the arising of a *dem*, i. e., a compound individual of a superior species. Thus he asks us to look for the object of sociology, not in the material fact of an aggregation, but in the *consensus* or convergence of forces represented by the uniting individuals, aiming at an end which is personal to none of them. In that sense his teaching seems to be of capital significance for the progress of the real social science. But that meaning can be only obtained from the spirit of his doctrine, not from its letter; and the great philosopher himself was more than once false to his own premises. It seems that Comte was not fully aware of the extreme difficulty of settling in a scientific sense the point where individual life becomes social, and we hasten to see how the far more learned English evolutionist—I mean Herbert Spencer—gets out of the whirlpool where the ship of the French positive philosophy foundered with all hands on board.

In his "Principles of Sociology" Herbert Spencer pays but little

* "Le colonie lineari e la morfologia dei molluschi."

attention to these preliminary questions as to the limits and the specific laws of sociology; and we are compelled to go back as far as his "First Principles," etc., to get a knowledge of the way in which those questions are answered by his system. This is to be regretted, not so much because of the practical inconvenience of perusing many volumes about matters but indirectly connected with the object of our researches, but far more on account of the impossibility of summarily reviewing so monumental a work in the few pages of this essay.

To French positivism, sociology appeared too much isolated from genuine knowledge by a gulf which Comte asserted to be unfathomable. With the modern scientific school, the danger comes rather from the opposite side, and sociology is threatened, so to say, with being swallowed up, or absorbed, by zoölogy.

Indeed, to botanists and zoölogists is due the capital discovery of the unquestionable fact that (with the single exception of the lowest monocellular ones) organisms are societies. And if we were arbitrarily to reserve the appellation of society exclusively to the *dems* of M. Cattaneo's classification, still we could not get out of the difficulty even by such an anthropomorphic (i. e., anti-scientific) restriction. An "organism is a society"—that great sensational thesis is imposed on our mind more and more with every new advance of natural science; while, on the other hand, the chief sociologists of these later years, starting from their more or less synthetic point of view, come to the conclusion that "society is an organism."* The great Darwinian law of the struggle for life, which is the specific law of evolutionary biology, plays a part still more and more prominent in the most recent sociological writings, and the very object of social science appears to be well-nigh dissolved in the vast domain of biology.

THE HICKORY-NUTS OF NORTH AMERICA.

By JOSEPH F. JAMES.

IT is a favorite pastime of our country population during the long winter evenings to gather round the fire and crack and eat hickory-nuts. It is an amusement, too, peculiarly American, and for the simple reason that in this country alone are the nuts to be had in any abundance. Perhaps, where almonds or English walnuts are equally common, cracking hickory-nuts is superseded by a resort to these other fruits. They, however, are much easier to open than the hickory-nut, and with thinner shells are readily cracked at the table. But in America, in those districts where the peanut does not take the place of other nuts, the cracking of the hickory still continues. Whether it

* See the "Revue Philosophique" of M. Ribot, for 1883, *passim*.

be the pecan of Texas and Illinois, or the shell-bark or mocker-nut of the Central or Eastern States, the amusement is the same. They are the best nuts the forests of North America produce, and some of them are thought to be superior in flavor to the much-esteemed English walnut.

Year after year have hundreds and thousands of bushels of the shell-barks, the hickory-nuts *par excellence*, been gathered in various parts of the country. Among these, few can have failed to notice the many differences they present. Some are small and nearly round; some are long, narrow, and angular; some have thick shells, and some thin ones, as any one who has cracked his fingers along with the shell can bear witness.

According to evolutionary doctrines, variability in an important feature is an indication either of a low state of development, or that the organism is in a state of advancement. Various facts show the latter to be the case with the shell-bark hickory. The first stages of the onward march must be sought far back in prehistoric times, for it boasts an ancient if not an honored lineage. Before the hairy mammoth roamed the forests of the Ohio Valley; before the soil of Louisiana was yet above the ocean's waters; before the Ohio had become tributary to the mighty Mississippi; before even the Rocky Mountain range had been elevated above the waste of waters, the ancestors of this hickory flourished in the land. But, before we study the ancient hickories, let us examine the living trees and note their peculiarities.

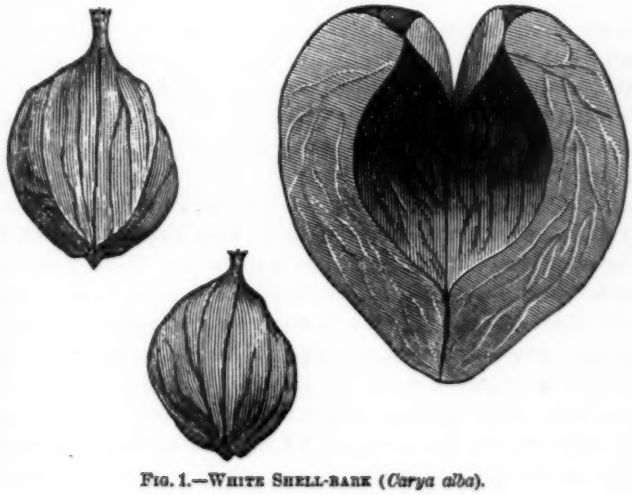


FIG. 1.—WHITE SHELL-BARK (*Carya alba*).

Were the same observers who saw the differences in the size and shape of the nuts of the white shell-bark to direct their attention to the husks of that fruit, they would find much variability there also. But these are secondary considerations with the nut-gatherers. If a

nut falls to the ground with the husk intact, the nutter gives it a kick with his boot-heel, or a blow with his stick, and separates the husk into its component parts. For this outer covering divides readily along the sutures and falls into four pieces. Sometimes the four form a nearly perfect ball; sometimes they are long and taper to a point; occasionally, three pieces will serve the purpose of four, but they are all dark green or brown on the outside, white with streaks or veins of brown inside, and they vary from a quarter to half an inch in thickness.

Yet another thing will the nutters notice, and that to their disappointment and disgust. This is the number of nuts having neatly cut, round holes in the shell. Out of these there will often be seen protruding the white body of a well-fed worm, which has been growing in size and strength since the egg hatched in the young nut. The grub grew with the growth of its house; it found an abundant store of nutriment, and it attains a size which makes it a matter of wonder how it manages to escape from the neat little round hole it has cut in the thin white shell.

Such is the fruit of the white shell-bark. The tree which produces it is equally interesting. The common name of shell-bark or shag-bark tells at once its most remarkable characteristic, and one by means of which it is most easily and readily recognized. The bark, instead of being securely attached to the trunk as in most trees, breaks loose from it and hangs in strips, fastened sometimes in the middle, sometimes at the upper and at other times at the lower end. The whole trunk thus presents a shaggy, rough appearance, and in some cases resembles the ragged ends of an ill-laid and worn-out thatch. This feature is only to be observed in trees of more than ten years of age, younger ones showing indications of what is to come.

It is a majestic tree, eighty or ninety feet in height, straight and without a branch for sometimes sixty feet, and then spreading out its bushy head. In the spring the young leaves make a very rapid growth, attaining a length of twenty inches in a short time. These leaves are divided into five leaflets, four being in two opposite pairs, and the fifth placed at the end. Each leaflet tapers to a sharp point and has saw-like teeth on the edges. The flowers are small, green, and form long, pendent catkins, arranged in bunches of threes, with the fertile or pistillate flowers at the base. The pollen is produced in immense quantities, and conveyed from the stamens to the pistils through the agency of the wind. The species is widely distributed over the country, ranging from the St. Lawrence Valley and Southeast Minnesota on the north, to Florida and Texas on the south. This extensive dispersion is perhaps one reason for the variability the nut presents, as under varied conditions it assumes diverse forms.

One of the nearest relatives of the white shell-bark is the thick shell-bark. In this species the nut is very large, has an extremely thick husk and shell, and a small but sweet kernel. The husk sepa-

rates into pieces, the flowers are alike, and the bark exfoliates in much the same way in both. There are, however, often seven instead of five leaflets, but they have a pointed apex and serrate edges. The tree is not so widely distributed over the country, as it is found mainly in the Mississippi Valley, north of the Ohio River. The very heavy shell, requiring severe blows with a hammer to crack, makes the reason for this more limited diffusion obvious. Depending almost solely on rodents for its dispersal, the size of the nuts preventing the wind from carrying them to any distance, the heavy shell makes it a most difficult task for the gnawers to penetrate to the kernel within. It will be readily understood that the thinner and yet sweet-kerneled nuts will be chosen in preference. And while mice and woodchucks and chipmunks and squirrels will lay up stores of the thin-shelled nuts, often carrying them long distances, the heavy-shelled ones will seldom be molested, but remain where they fell near the parent tree. The heavy shell would, again, be an impediment to germination, and thus fewer individuals would grow, and those which did sprout would have little chance of attaining maturity while overshadowed by the older tree. Thus we have a simple explanation of the fact of the limited distribution and the small number of individuals in any given area.

FIG. 2.—THICK SHELL-BARK (*Carya sulcata*).

The near ally of this species is another heavy-shelled sort, the mocker-nut, which has a much thinner husk and yet a thick shell.

FIG. 3.—MOCKER-NUT (*Carya tomentosa*).

The nut is quite large, intermediate in size between the white and the thick shell-bark, of a yellowish color and a sweet kernel. The bark has not the scaling propensity, but the flowers and the leaves are quite similar. Its distribution is wider than the thick shell-bark, but it is still limited. One peculiarity is observed in all three species, and that

is the great variability in the shape of the nuts, a feature that is much less marked in all the other sorts.

The white shell-bark occupies a sort of intermediate position in the genus. On one hand are the thick-shelled species already noted, forming one line, and on another line are two species marked in other ways, but mainly by a difference in the kernel. While in the three already described this is sweet and palatable, in these other two it is bitter and uneatable. These have, also, thin instead of thick husks, and they separate only about half-way down instead of into four distinct pieces. The shell is thin, so much so in some cases as to be easily crushed in the fingers. In size, shape, and markings there is none of the variability of the shell-bark. Of the two species the bitter-nut is

FIG. 4.—BITTER-NUT (*Carya amara*).

the more common. The bark is close; the tree grows to be forty or fifty feet high, the shell is smooth, sharp-pointed, and marked with lines, while the kernel is so bitter that it is rejected by squirrels and other animals as long as other food can be obtained. The leaflets are small, from seven to nine in number. Its distribution is limited to nearly the same area as the mocker-nut, namely, the valleys of the Ohio and its tributaries, Minnesota, Kansas, and Western New York.

FIG. 5.—WATER-HICKORY (*Carya aquatica*).

FIG. 6.—SMALL-FRUITED HICKORY (*Carya microcarpa*).

The water-hickory has many of the same features, but the shell of the nut is thinner still, and the kernel yet more bitter, while the tree is confined to the swamps of Carolina and Georgia, where it is by no means common. Its nut is of a reddish color, and more or less angular.

On a third line running from the white shell-bark are three other species. One of these is the small-fruited hickory, in which the husk and the shell are both thin, and the kernel, though small, is eatable. It is closely allied to the white shell-bark, and by some considered a

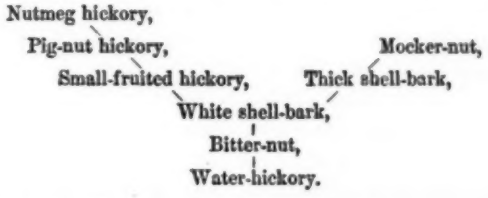
variety only. A second species is the pig-nut, which has a thin husk but a thick shell. The kernel is small, and, though agreeable at first, soon becomes bitter and disagreeable. It is never eaten by man, but

FIG. 7.—PIG-NUT HICKORY (*Carya porcina*).

FIG. 8.—NUTMEG HICKORY (*Carya myristicæformis*).

used to feed hogs, or left for the wild animals. This nut is somewhat variable in shape, sometimes being distinctly pear-shaped and then again round. Michaux says that the same tree yields nuts as large as the thumb and others as small as the little finger. The third species in this same line is the nutmeg hickory, which has a somewhat rough husk, with a smooth nut, lined with streaks of white, and a shell so thick as to constitute one half of the whole nut. The kernel is inferior even to the pig-nut hickory.

If all these species were to be arranged so as to show their affinities, something like the following diagram would result:



From facts already given it will at once be apparent that two features in the nuts are correlated. The thick-shelled nuts have sweet kernels, though they differ in edibility, and the thin-shelled ones are invariably bitter. Thus the sweet ones protect their kernels by incasing them in hard shells—a precaution unnecessary for those whose kernels are bitter, because they are protected by this feature alone.

There remains, now, one species to be considered, and that is the pecan. While the white shell-bark seems to occupy a central place among the species, the pecan is intermediate between the hickories and the walnuts. These two genera, *Carya* and *Juglans*, as botanists know them, constitute the main part of the order to which they belong. When two genera are as closely allied as these are, an evolutionist accords a common origin to both. In fact, the difference between the two is a technical and comparatively an unimportant one.

It is the presence in the hickories of staminate flowers in clusters of threes, while in the walnuts there is but one; and by the more or less complete separation of the husks of the hickories into four pieces, while the walnuts have no such division.

Now, the pecan is allied to the walnuts by the number of its leaflets (thirteen to fifteen, while the walnuts have, in one species, seven to eleven, and in others fifteen to twenty-one), and by having its catkins separated at the base instead of being united. And it agrees with the hickories in having three catkins instead of one, and by the husk of the fruit separating into four pieces. The kernel is very sweet, the husk is thin, and the nut smooth and rather thin-shelled. The peculiar feature of a bitter division between the two halves of the nut is an approach to those hickories having a bitter kernel: while the hard shell and the sweet kernel ally it to the shell-bark. The tree is confined now to the States near or bordering the Mississippi River, and is thus the nearest of all the species to that spot which was once thickly clothed by its ancestors. It is noteworthy, too, that the walnuts approach the same habitat, and in the case of one species extend across the continent to California.

FIG. 9.—PECAN (*Carya olivæformis*).

From an aboriginal ancestor which probably possessed a many-parted leaf, and a fruit with an entire husk and a thick shell, there came two branches. One of these, retaining the numerous leaflets, developed a nut with a corrugated shell and a thick, green husk, represented by the living species of walnuts. The other branch gave rise to a species having a nut resembling the pecan, with a smooth shell, and a husk separating more or less completely into four parts. Some of the various stages of development from such an ancestor have probably been preserved to us. The white shell-bark may be regarded as a modified descendant in which the bitter internal division has been lost, and the outer shell strengthened to afford additional protection. The mocker-nut and the thick shell-bark have acquired a still stronger covering to protect them in the same way. The small-fruited hickory is probably a stepping-stone to the pig-nut, with its thick shell and partially bitter kernel; while the thin-shelled bitter-nut and water hickory are other offshoots in which the bitter kernel does away with any necessity for a hard and thick shell.

The geographical distribution of any species or genus is an interesting and important adjunct to its history. At the present day, all the species of hickories are natives of North America east of the Rocky Mountains. Two out of four of the species of walnuts are confined to the same limits; a third is native to California and Mexico;

and the fourth, the English walnut, is a native of Persia and the Caucasus. In times past the distribution was far different. What information we have is derived only from a confessedly imperfect geological record—a record exposed and explored as yet in the Rocky Mountain region, in Alaska, Greenland, and Central Europe. In all of these places species of either the one or the other genus have been found. It is true that the determination of species or even genera is difficnlt from fragments of leaves, but, as far as is now known, the following are the facts:

During that period of time known as the Cretaceous epoch, a tropical climate prevailed over the whole of the northern hemisphere, even to the pole itself, and probably also over the whole world. During that time forests of trees flourished over the continent of North America, over Europe, and probably Asia also. These forests were, in many respects, similar in aspect to those which at present clothe portions of the Ohio Valley. What species of trees lived in that part of the country north of Virginia and Tennessee and east of the Mississippi, it is now impossible to tell. But west of that river, and over the larger part of the Rocky Mountain region, there grew forests in which poplars, willows, oaks, beeches, sycamores, gums, magnolias, and perhaps walnuts and hickories, were the prevailing types. The remains of all but the last two have been found in the immense series of Cretaceous rocks of the Western States and Territories, having fortunately been preserved in the deposits of the shallow seas or great lakes which then occupied that part of the American Continent. The genera mentioned are but a few of those of which remains have been found, but they indicate a similarity in the flora then to that of the present epoch. Many of the same genera are found in strata, of presumably the same age, in Alaska, Greenland, and parts of Europe, and these facts indicate not only a similar climate in all these localities, but a similar forest aspect.

In the Tertiary formations, coming after the Cretaceous, the resemblance to modern trees is still more striking. During this later period, that part of the Rocky Mountain region which had before been under water was elevated above the surface, but immense basins remained which were filled with brackish or fresh water. It is in these fresh-water deposits that the abundant remains of ancient forests are found. Many of the same types present in the Cretaceous period are found in the Tertiary in still greater numbers. If there be any doubt about the occurrence of walnuts and hickories in the former period, there can be no question about their being in the latter one. The number of species of oaks, poplars, figs, ashes, magnolias, and many others equally well known, was increased. But we shall here consider the two genera, the walnut and the hickory.

In Europe one species of walnut is found in the Cretaceous rocks, and a doubtful one is mentioned as found in rocks of the same age in

America. The lowest series of Tertiary rocks in Europe contains remains of three species, and the upper series of no less than forty-three species. The hickory seems to have appeared in Europe in the middle Tertiary, and in the upper beds is represented by twenty-one species. In America the walnut is well represented in the lowest Tertiary, and increases in numbers toward the top; while the hickory is represented by several species through the whole series. When the living species of these two genera are considered, a widely different state of affairs appears. The forty-three species of walnuts dwindle to one; the hickories are entirely absent, though perhaps represented by three somewhat different genera now growing in Japan and parts of India.

The fact that many genera of Tertiary plants are common to North America, the Arctic regions, and Central Europe, is evidence of some former land connection. This connection was probably at the northern ends of the continents, and it allowed the free commingling of the floras of the two bodies of land. When at the close of the Tertiary vast changes took place in the distribution of land and water; and when a wave of extermination swept over the northern and western portion of this continent, the same disaster overtook the forests of Europe. The eastern half of North America and the eastern part of Asia seem to have escaped the effects of the vast change; for in these two regions are still found the remnants of the previous floras. Europe and the Rocky Mountain region suffered from the throes of mountain-making, and the disastrous effects of these convulsions are shown in the extinction of the luxuriant flora and the varied fauna which had previously existed.

Thus it can be seen that our hickory can boast a pedigree which puts to shame the mushroom-growth of modern days; and, while the descent can not be traced in a direct line through all the intermediate stages, we can safely formulate the main facts. The ancestor of both walnut and hickory orignated toward the beginning of the Cretaceous period. The separation of the two occurred toward the end of the same epoch, and they both spread during the highly favorable period of the Tertiary over the whole country and across the Arctic zone into Europe and Asia. The continental condition of Eastern North America and its lack of large, shallow lakes forbade the preservation of such forms as existed there; and the comparatively small portion of our Western region which has been explored has prevented the discovery of many of the species then living there. Yet there can be little doubt but that, if our knowledge of pre-existing species was sufficiently full, we should be able to trace back to some common ancestor all nine of those species of hickory which now live in our country, and the fruits of some of which annually contribute to the enjoyment of hundreds and thousands of our people.

THE HYGIENIC TREATMENT OF CONSUMPTION.

By BENJAMIN WARD RICHARDSON, M.D., F.R.S.

THE progress of hygienic medicine in the last fifty years is the medical fact of the present age, and the fact that will stand out in boldest relief when the history of this period shall be written by some future Æsculapian scholar.

But, rapid and effective as this progress has been, the principles of hygiene are yet in their infancy. We have learned to appreciate the true value of hygienic principles in the prevention of diseases of the epidemic type ; and the medical profession, throwing aside all selfish recollections, has been the first to teach the practice of these principles and to prove their force and vitality. The next step in the way of advancement is to demonstrate that the same principles are as useful and as necessary in the treatment of actual disease as they are in prevention.

A great advantage in the hygienic treatment of disease is, that it does not, or at least need not, interfere with sound and experience-proved modes of treatment of a medicinal kind. The scientific physician finds, in fact, that there is always a consistent plan for combining the medicinal and hygienic systems. He sees that the two systems are one ; he sees further that the mere medicinal plan without the hygienic is in all cases imperfect, and in some cases worse then imperfect.

The practical details of hygienic medicine in relation to the treatment of disease have, however, yet to be wrought out more fully. This will be sure work, but slow. Necessarily slow, because it is hard to give up old friendships in dogmatism ; while to effect a cure in a sick man by fresh air alone, or diet, is infinitely less satisfactory to the public than to assume to effect the same cure even by a bread-pill.

It is vain, it is sticking in the slough of hopelessness, to pander to these popular weaknesses ; for though they must die out, and, indeed, are dying out daily, they will go the sooner if they are effectually damped, and if something real and common sense is put in their place. *Scientiæ mutantur, et nos mutamur in illis.* There is a time when medicines are invaluable ; but, if faith in medicines is to be retained, the times for their administration, as well as their selection, must be learned by knowledge, not by routine, and must be dictated by the circumstances of the case, not by the caprice of the patient. The executive of medicine must be independent, if it would keep in the path of truth and advancement.

In such progress as has been made in the science of treatment by medicines, it has been found useful to take up certain particular diseases, and to observe in them, individually, the effects of particular remedies. This rule will apply with equal force in considering and

investigating hygienic modes of treatment. Each practitioner should, as his opportunities permit, observe as carefully the effects of his hygienic commands as he does those of the medicines he may prescribe. He should compare also the one mode with the other, and calculate in each case their relative advantages. In this way he will have the opportunity of detecting with greater accuracy the pure effects of medicines themselves; seeing that the action of medicines is greatly modified by the external conditions to which he who takes them is subjected.

Convinced of the importance of the above considerations, I have made it my business for thirty years past to mark out a series of hygienic rules for the treatment of consumptives; and as I have had the best and widest opportunities of carrying out these rules in practice, and as the results have been satisfactory, I lay the views published, originally, while I was one of the physicians to the Royal Infirmary for Diseases of the Chest, once again, and briefly, before the public.

In giving the following rules, I presuppose their general applicability to cases of consumption in all stages of the disease: in the premonitory stage; in the stage when the tubercular deposition is evident; and in the next stage, when the local mischief is much further advanced. In the last stage even, though hope is lost, many of the rules may still be followed out with advantage, for by them the course of the disease is smoothed, and sometimes life is prolonged. In like manner, the rules are generally applicable to those who by hereditary taint are as yet but predisposed to the disease.

RULE I. *A Supply of Pure Air for Respiration is the First Indication in the Treatment of the Consumptive Patient.*—In all cases of consumption, the attention of the physician should be at once directed to the quality of the air breathed by the patient.

In large cities, and even in small towns, it is next to impossible to get a constant supply of pure air in inhabited houses; for houses are built according to false notions of comfort. "What a nice, cozy room!" is a common expression applied innocently to every place where the greatest care has been taken to make an air-vault, without a "draught," and all ready for being charged with invisible impurities.

In a cozy room the consumptive is bound never to live, nor, indeed, in any one room for great lengths of time. So long as he is able to be out-of-doors, he is in his best and safest home. In the fields, on the hills, wherever the fresh air vivifies, where plants look most vigorous, and animals frisk about in the joy of health, there will the consumptive draw in his choicest medicine, there meet most advantageously the dangers of his disease, and there repair most easily the waste of tissue.

The inclemencies of the weather may temporarily, it is true, prevent the patient from his out-door existence. But even these inclemencies are not so much to be dreaded as confinement in a house. I have

had occasion repeatedly to remark that if, from a few days' rain, the consumptives under my care were confined to their homes, instead of being able to take the daily out-door breathing invariably prescribed under such circumstances, the aggravation of symptoms was always marked and universal. The appetite fell off, the debility became greater, the mind was less buoyant, the local mischief increased. The patients, too, previously accustomed to a full dose of the air-food, were not ignorant of the cause of these changes, for reduction in air is felt as quickly as reduction in common diet. Seeing these evils, then, I have long since thrown off the alarm about bad weather, and have ordered every patient to seize, even in an inclement day, each gleam of sunshine, for the purpose of getting out for a breath of fresh air. The result of this practice has been most gratifying in all cases where the courage of the patient has admitted of its application.

Dr. Jackson, in speaking of out-door life, in much the same terms as the above, dwells very properly on the necessity of securing for this plan the confidence of the patient. The treatment "should not be done rashly, but boldly." If possible, "the patient should be made to have faith in it; for without this he is not likely to pursue it as far as he can, and then he will not derive from it all the benefit which it can afford." This is the fact; but the difficulty is at once got over if, under favorable conditions, the invalid can be induced to try the measure for a few days. Once tried, there is no fear, in the majority of cases, of its being given up, except in instances where the disease is too far advanced, or where, from the poverty of the patient, the pursuit of a sedentary occupation must needs be followed, even to the last days of existence. The benefit derived from this treatment is indeed so obvious, the debility is so much better borne, the relish for food is so much more markedly felt, the nights are passed with so much less of restlessness and cough, and with such an increase of sleep, that the sufferer soon instinctively feels the value of his instructions, and follows them out even more punctually than those which relate to the taking of medicines.

As much of the day, then, as is possible should be spent by the consumptive in the open air, and in places where the air is least impeded and least corrupted. When he is compelled to keep the house, the necessary precautions must again be taken for procuring a free admission of the atmosphere. No cozy room with a temperature of 70°, with every crevice closed, and with an atmosphere in a dead calm and laden with impurities, should be permitted. But the temperature should be 60° Fahr.; the fire, if there be one, should be in an open grate; and by a free chimney-vent, secured by an Arnott valve, the freest possible current of air should be kept circulating through the room. If the patient is cold, let him approach the fire, but let him not labor under the popular and fatal error that the way to obtain animal warmth is to shut out the air and roast the body. The heat

of the body is made in the body itself, by virtue mainly of the oxygen supplied in the air; and, as the body absorbs external heat with great difficulty, it would be as wise to attempt to give warmth by fires, hot bottles, and hot air, to a man who is not inhaling a due amount of oxygen, as to attempt the same process on a marble statue. In a word, external heat is useful only in preventing the too rapid radiation of animal heat from the surface of the animal body. Alone, it can not supply heat; but, when a wholesome air is inspired, it can secure the retention of the heat that is developed in the animal furnace.

I spoke a moment ago of the open fire-grate. This is an essential for the room of the consumptive. Stoves of all kinds, heated pipes, and, in a word, all modes of supplying artificial warmth, except that by the radiation from an open fire, are, according to the facts which I have been able to collect, injurious. They are injurious because by their means the air is made too dry, an objection much less applicable to the open fire.

The symptom which I have most commonly seen elicited in the phthisical, by the inhalation of an unnaturally dry air, is hæmoptysis, a symptom brought on frequently by the constant cough which the dry air excites. This effect, in a minor degree, will, in fact, appear in some cases without any actual deposition of tubercular matter, under the influence of the same cause.

The temperature of the air in the room of the consumptive should be carefully watched by the patient himself. My friend Mr. Glaisher, than whom no one is more competent to speak on this point, recommends two thermometers, the one with a wetted bulb. By the use of these the humidity, as well as the temperature, can be regulated. This is most advantageous, and the sensations of a consumptive patient soon inform him what degree of moisture is comfortable and proper.

I have occasionally heard phthisical patients complain of the use of gas in the rooms where they are confined. Such complaints, however, have usually come from patients confined in workshops where the number of burners is very great, and where there is almost always some accidental escape of gas.

In private houses such objections are avoidable; but as the inhalation of coal-gas is injurious even in small quantities, and as the products of the combustion of the gas are also hurtful, the necessity of a free ventilation in rooms where it is burned, and in which consumptives are lodged, is the more urgent.

The care that should be taken to secure a good air in the living-rooms of the phthisical invalid must extend with equal care to the sleeping-apartment. This rule should always obtain when possible: *never permit one room to perform the two offices of bedroom and living-room.* The bedroom should be large, unencumbered by needless furniture, and thoroughly ventilated. If the temperature of the air without is not below 60° Fahr., the windows of the room should be

boldly set open, and be kept open at the top all night. If they are to be closed of necessity, a free chimney-draught must be procured, and an Arnott's valve is always an advantage. The bed should be free of curtains, but a single screen may be placed so as to ward off any direct draught from the door or window. Warmth of body is best secured by woolen bedclothes; but, if the temperature of the air is below 60° Fahr., it will, with advantage, be raised to that pitch by a fire in the open grate. Gas should on no pretense be burned through the night in this bedroom, and as few other lights as possible, for the patient requires all the air that is to be had, and must not be carelessly robbed of it. Above all things, the consumptive person should be the sole occupant of his own bed and bedroom. To place such a one for several hours close to another person, however healthy, is injurious to both, but especially to the sick. No ties of relationship, and no mistaken kindness, should cause this rule of isolation ever to be broken.

It has been stated already that the room of the sufferer should be large. It should include, whenever practicable, at least fifteen hundred cubic feet of breathing-space, under all plans of ventilation. If more space can be had, all the better. If less only is obtainable, then the ventilation must be the more carefully attended to.

When the patient has left his room in the morning—and he should do so early—the windows and doors should be set open, and a current of air be allowed to flow through it during the whole of the day. If the air of the apartment be at a temperature below 60° Fahr., or loaded with moisture, the fire should be lighted two hours before bedtime.

Consumptive patients frequently ask, especially in winter-time, the value of what are called respirators; and I have known some poor people purchase things of this description at what was to them considerable cost. The use of mufflers, which are, in fact, respirators, has been known for ages; and Dr. Hales, more than a century ago, recommended a scientifically made muffler for persons obliged to enter into places where noxious gases were given off. Dr. Beddoes, too, as Dr. Arnott shows, pointed out, in the year 1802, that a few folds of gauze held over the mouth and nose made the air warm and moist for respiration, and that such mufflers were, therefore, useful to consumptive and asthmatic persons. The object of the muffler or respirator is this: it retains the heat thrown out in the expired air, and gives up this heat to the cold air that enters in inspiration. In cold, dry weather, the muffler is very useful, and should be worn by all phthisical patients when out-of-doors; but when the air is moist and cold it sometimes is complained of as embarrassing the respiration. It should then be thrown aside. Any patient may easily make one of these mufflers for himself, for the cost of a few pence, out of a piece of fine wire gauze, cut oval so as to cover the mouth and nose and fixed in the center of a small Shetland shawl, so that it may be tied on like an ordinary comforter, with the gauze in the center for breathing through. The metal

gauze, plated or silvered to prevent rust, will last for several months, and in summer-time can be removed from the shawl and laid aside; but the shawl is often useful in all seasons.

RULE II. *Active Exercise is an Essential Element in the Treatment of Consumptives.*—The conditions for obtaining a due supply of air imply in some measure the necessity for exercise. But there are varieties of exercise. Drs. Rush, Jackson, and Parrish, are in favor of riding on horseback, but this is a thing not practically to be carried out in the majority of cases, and, as I think, not absolutely necessary. Walking is the more natural exercise; it brings into movement every part of the body, more or less, and, leading to brisker circulation in every part, causes a more active nutrition generally. Of late years I have very much recommended tricycling to consumptive patients, and often with great benefit. In many instances it is better than walking exercise, giving more perfect change of air and scene with less fatigue.

The extent to which exercise should be carried will vary with the stage of the disease, and temporary accidents—such, for instance, as an attack of hæmoptysis—may, for the moment, stop it altogether. But, when exercise is advisable, the general rule is to recommend that it be carried out systematically, cautiously, and courageously, and that each exercise should be continued until a gentle feeling of fatigue is felt through the whole muscular system. Violent and unequal exertion of the upper muscles of the body is unadvisable. When restored from the fatigue of one exercise, another should be undertaken, and during the day this can not be too often repeated. If the day be wet, then the exercise should be effected by walking in a large room, or by engaging in some game, such as skittles, billiards, or tennis.

If, in his waking hours, the consumptive patient can keep himself occupied pretty freely in muscular labor, he secures the best sudorific for his sleeping hours that can possibly be supplied; for as the force of life is always expended in producing motion or action, so, to use the words of Dr. Metcalfe, "the proximate cause of sleep is an expenditure of the substance and vital energy of the brain, nerves, and voluntary muscles, beyond what they receive when awake; and the specific office of sleep is the restoration of what has been wasted by exercise." Cough is very much less frequent in the course of the night in him who has been subjected to exercise in the day; while sleep, when it falls, is more profound, more prolonged, and more refreshing.

In summer-time, when the temperature of the day is high, the morning and the evening time are the best adapted for the periods of out-door exertion. In the other seasons, midday is preferable, as a general rule.

I have been asked, often, whether dancing is good exercise for children and young persons of a consumptive taint. There can be no doubt that it is so when properly conducted. When dancing is carried

on, however, it must be done in a very large room, freely ventilated, and scrupulously free from dust; for, the more exercise the body takes, the more air it requires, and the less of incumbrances in the way of mechanical obstacles to a free respiration. In damp days, when walking out-of-doors is impossible, the consumptive child may thus have three hours' dancing with advantage; not in stuck-up bowing and scraping, finnicking, polite quadrillism, but in good active dances, that make every limb feel pleasant fatigue.

In the performance of muscular exercise let the consumptive never encumber himself, nor check the free movements of his body, by strappings, loads of clothes, carrying of weights, and the like. These are but tasks; they lead to unequal exertion in special sets of muscles, and to an inequality of expenditure of power which ought to be avoided.

A last consideration on the value of muscular exercise is, that it is eminently useful in keeping the respiratory muscles in a state of active nutrition. For, if to the loss of capaciousness in the lungs to receive air there is added a daily increasing failure in the muscles by which the acts of inspiration and expiration are carried on, it is clear that a double evil is at work. Now, this double evil is most actively presented in consumption. As the respiratory muscles, together with the other muscles, lose their tone, so do the general symptoms of exhaustion increase in severity, sometimes without very marked change in the pathological condition of the lungs. In sequence, day by day, as the nutrition of these muscles decreases, and as they fail in tonic contractile power, they gain in excitability; so that the irregular spasmodic contractions to which they are subjected in the act of coughing are produced by the merest excitement, and the cough is more frequent as it becomes more feeble.

RULE III. *A Uniform Climate is an Important Element in the Treatment of Consumptives.*—Consumptive patients are constantly asking questions as to the value of a change of climate. The poorest applicants for relief are anxious on this point, and are often ready at once to contemplate emigration, if the merest hope is given to them that such a course would prove beneficial. In considering climate, the fact should be remembered that the main point to be obtained is to select such a part of the earth's surface as presents the nearest approach to an *equality* of temperature. Different writers of eminence have given the most contrary opinions on climate and consumption. Some have recommended a warm climate, others the polar regions. Both parties have spoken from experience, and they are, in some measure, both right; for a climate equally cold and a climate equally hot are each much more favorable than one in which there are constant variations, and where the thermometer in the course of the year ranges many degrees from freezing-point up to 100° Fahr. or higher. Speaking of 153,098 deaths from consumption occurring between the years 1841 and 1851, the Irish Census Commissioners observe:

"As might naturally be expected, the seasons exercised a very marked influence upon the deaths from consumption. During the mild months of autumn, succeeding the warm season of summer, the deaths attributed to consumption amounted to only 23,010; with the cold of winter the mortality from this cause increased, so as to present a return of 38,956; but with the harsh, trying weather of spring it rose to 51,334, and in summer fell again to 39,798."

This statement represents a very important truth. It is certainly best for the patient if the temperature, while equal, be also temperate; but a mean temperature of 35° on one side, or 75° on the other, is preferable to one varying constantly, to-day at 60° Fahr., to-morrow at 40°, and a few days later at 80°.

From the experience gained in taking charge of a large number of consumptive patients it becomes a remarkable and highly-instructive task to learn the influence of climatic changes on the symptoms of the disease. I can usually predict, almost with certainty, the history I am to hear from the consumptives who are coming before me. If for some days there has been uniformity of temperature, and the weather has been mild and dry, so that an airing each day out-of-doors has been effected, the visit is quite a cheery one; all seems better; the medicines are said to agree. The cough is less troublesome, the body is warmer, and hope, diffusing an inward sunshine, lights up each face with brightness and activity. In frosty days, too, when the air is dry and the temperature continues even, the symptoms are often equally favorable; but during periods, so common in this country in the spring and in the beginning of winter, when the atmospheric variations are sudden, marked, and often repeated in the course of a few weeks, the general aspect of affairs is widely different. I have heard on these occasions almost every patient complaining; the symptoms are all exaggerated, the mind discontented. There is a general request for a change in the medicine. Something is asked for that will soothe, for the nights are passed indifferently. It is useless to comply always with these demands, since the exaggerated train of complaints has a general and common cause; but now and then the modification of symptoms is so great as to call for a modification of treatment. During these variations of season, deaths from consumption are most prevalent.

Thus an equable temperature is of great moment, and should always be sought after by the phthisical sufferer. If he can not remove from his own locality, and if the variations in it are considerable, he must take the best precautions at his command. In-doors it is not difficult to sustain a pretty even temperature, varying from 55° to 60° Fahr. Out-of-doors, something must be done by attention to clothing, and by the use of the respirator. The most marked variations, however, occur in the night, and hence the importance of keeping up an equality of warmth in the bedroom, in the manner already described.

The reasons why consumptives feel the effects of climatic changes so much are sufficiently obvious. The effects of such variations are felt, indeed, in the best health; for the body is in some measure both a barometer and a thermometer; at all events, it is subject to the same influences, the lungs being in all cases the parts most affected. With the temperature moderately high and the air dry, the physiology of respiration is carried on easily and well. The amount of oxygen taken in is ample; the expiration of water, carbonic acid, and ammonia is free; the pulmonic circuit of the blood is unimpeded; the exhalation of water from the skin is unchecked; and the radiation of heat from the body is moderate. Let these atmospheric conditions suddenly change for those in which the temperature is 35° Fahr., or less, and in which the air is charged with watery vapor, and the conditions of life are materially modified. The supply of oxygen taken into the lungs is less; the process of absorption of such oxygen by the blood is less; the expired products are lessened; the pulmonic circulation is impeded; the watery exhalation from the skin is, in part, suppressed; the radiation of heat from the body is much more rapid; and, as a result of all, the whole man, body and mind, is enfeebled in force and in vitality. This is the course of things in a healthy man during atmospheric variations. It is left with the reader to trace out the exaggerated evil of these changes in those who, at the most favorable times, are existing with the lungs reduced in capaciousness and the respiratory muscles in power.

I shall recommend no particular place as a resort for consumptives; for I wish not to enter into disputation on this point. But here is the formula for an hypothetical Atlantis for consumptives: It should be near the sea-coast, and sheltered from easterly winds; the soil should be dry; the drinking-water pure; the mean temperature about 60°, with a range of not more than ten or fifteen degrees on either side. It is not easy to fix any degree of humidity; but extremes of dryness or of moisture are alike injurious. It is of importance in selecting a locality that the scenery should be enticing, so that the patient may be the more encouraged to spend his time out-of-doors in walking or riding exercise. A town where the residences are isolated and scattered about, and where drainage and cleanliness are attended to, is much preferable to one where the houses are closely packed, however small its population may be.

In speaking thus of the value of an equal climate, I am guided chiefly by the facts daily presented to me in relation to climatic variations on patients living in these islands. Some authors, however, infer from mortality returns, gathered from various quarters of the world, that variations of climate do not materially affect the disease, but that it is uniformly more fatal in cities than in the country. In England the excess in cities is equal to twenty-five per cent.

The facts are not opposed to the value of climatic uniformity. On

the contrary, they prove the value; for as consumption is most rare in extreme northern climates, and at great elevations, so in these localities are variations of climate less marked. It remains yet for statistics to show whether in the most favored patches of earth, where, with the absence of climatic variations, there is a genial but temperate warmth, the disease is less prominent and less fatal.

RULE IV. *The Dress of the Consumptive Patient should be adapted to equalize the Temperature of the Body, and so loose that it interferes in no way with the Animal Functions.*—Instinctive sensations both in health and disease naturally dictate the above rule. But it is too commonly the fact that these sometimes are disobeyed. Some persons think it a hardy, and therefore a beneficial, plan to dress lightly in all weathers. Foolish mothers send out their children in mid-winter with bare legs and chests; young ladies go to balls and evening parties with the upper part of their light dresses open over the throat and bosom. Others go on a different tack; they must at all seasons be smothered up in flannels and outer dresses, layer upon layer, carrying with the severest fatigue as much weight of cloth as they possibly can. Such persons on both sides evidently misunderstand the uses of clothes, or think them only ornamental appendages. Clothes are useful, in a sanitary point of view, simply as equalizers of temperature. Heat is transmitted slowly through flannel, so flannel is warm. For this reason, flannel which should be worn in winter is unnecessary in summer, unless it is of light and porous structure.

I speak here of the body in health. In the consumptive patient, the principle is modified. He, from the deficient play of his lungs, is virtually always living in winter; and we may find him on the hottest days breathing with anxiety, and with his hands and feet and brow cold.

For the consumptive, therefore, flannel clothing is always required, and it should cover the whole of the body. The thickness of flannel must vary according to the sensations; as far as is possible, the feeling of absolute cold ought to be at all times prevented. The consumptive should sleep also in flannel; not in the dress worn during the day, but in a flannel gown. The shoes worn should be lined with flannel.

A common practice in the selection of clothes is to imagine that the weight of a garment conveys an idea of its warmth-sustaining power. This is an absurd error, and for consumptive persons this mistake about heavy clothing must be carefully avoided. They may safely trust to flannel of so porous a texture that it can be breathed through without offering any appreciable obstacle to the breath, and they may then walk out as warm as they can be made by clothing, without the risk of being wearied from the burden beyond their powers of endurance.

All absurdities in the way of hare-skins, warm plasters, and the

like, placed specially on the chest, are useless; and the plaster is worse than useless, since it checks the functions of the skin over a considerable surface, and is soon dirty.

There is one modern article of attire on which a word of caution must be said, because its bad effects are unmistakable. I must warn all, but the consumptive in particular, against wearing what are called water-proof India-rubber coats. The healthy man may tolerate one of these garments; the consumptive, never. It loads the under-clothes with moisture; it gives a cold envelope to the surface; it produces chill; and, by checking the cutaneous function, it throws a double amount of work on lungs already failing under their ordinary duties.

Is it necessary to more than condemn those abominations of female attire, corsets? I hope not. But not less injurious than the corset is the practice of placing a strap or belt round the waist, tightly buckled. In the old times, the ascetics wore the tight strap as a penance for sin. This was surely the true and original function of the article. Now it is a penance worn for society in a foolish mood.

RULE V. *The Hours of Rest of the Consumptive Patient should be regulated mainly by the Absence of the Sun.*—If exercise is important to the consumptive patient during the day, a due allowance of sleep is equally necessary during the night. The natural hours of sleep are from sunset to sunrise, and it is the business of the consumptive to make Nature his oracle. Shakespeare has happily said that sleep is the "chief nourisher of life's feast," and Menander held that it was "a remedy for every curable disease." The great use of sleep truly is to renovate; for in the sleeping state the formative processes go on most actively. Metcalfe has well defined the difference between exercise and sleep by saying that "during exercise the expenditure of the body exceeds the income; whereas during sleep the income exceeds the expenditure."

It is obvious that to the consumptive person nothing can be more important than that the income should alternately and at natural seasons exceed the expenditure; and it is quite remarkable how much alleviated all the symptoms of consumption are when sleep is insured. The rule I have laid down regarding the hours for sleep is imperative for many reasons: First, because in all seasons the actual amount of rest required by the natural man is pointed out by the course of the sun. Second, because to extend the day by artificial lights, making a little sun out of a gas-lamp or candle, is to feed that lamp with a part of the breathing store of the air, and vitiate the atmosphere. Third, because, though artificial light is injurious, the pure sunlight is, on the contrary, of the greatest worth in the acts of vitality.

Thus, to fulfill the natural law regulating the times of sleep, to escape from the artificial light, and to obtain the advantage of all the sunlight that can be secured, the consumptive patient should make the sun his fellow-workman.

As soon as the patient has risen, he should at once leave his bedroom; and, if the morning be fine, he should go into the open air. On this point Mr. Bodington, in a short essay "On the Treatment and Cure of Pulmonary Consumption," published in 1840, dwells with great force. "The profuse nocturnal perspirations are soon subdued," says Mr. Bodington, "by this method of treatment, and the debility they occasion avoided. The skin assumes a healthier action in proportion to the extent of exposure to the external atmosphere, particularly to the morning air."

In large towns the practicability of this last suggestion is less than in the country; but, even in London life, an early morning walk should be made a matter of strict business by the consumptive. On a fine summer morning, between four and five o'clock, a walk through the streets and squares of London is, indeed, a treat which few Londoners understand. The air is free of smoke; the thoroughfares are royal unimpeded highways; and, while the great population sleeps, the magnitude of its residence is best seen and understood.

RULE VI. *The Occupation of the Consumptive Patient should be suspended if it is in-door or sedentary; but a certain Amount of Out-door Occupation may be advantageous.*—This rule is often difficult to carry out. At the same time it is second to none in importance, as there is, in a word, no exciting cause of consumption so general as in-door occupation. I remarked that about two out of every three patients with consumption, who presented themselves before me at the Royal Infirmary, were employed in some in-door business. This was confirmed accurately by reference to the Infirmary books, the figures of which were very carefully analyzed for me by Mr. Pring, a student and assistant at the institution.

Out of five hundred and fifteen cases of consumption, not less than 68·34 per cent, or rather more than two thirds, were persons following in-door occupations. Possibly the percentage was even higher, for all who called themselves laborers were presumed to be out-door workers. Among the in-door occupations which presented the largest number of cases in this list, boot- and shoe-makers ranked first; needlewomen, second; watch- and clock-makers, third; domestic servants, fourth; painters, fifth; tailors, sixth; printers, of whom the majority were compositors, seventh; bookbinders, eighth; French polishers, ninth; cigar-makers, tenth; writers, eleventh; smiths, twelfth; tinmen, thirteenth; and cabinet-makers, fourteenth. There were, altogether, in the list one hundred and forty trades specified, but the above-named fourteen yielded rather more than forty-four and a half per cent of the whole.

In the case of parents having children of a consumptive tendency, the greatest care should be taken to obtain for them out-door employment. But here a serious delusion commonly comes into play. If the child is weakly, the anxious parent urges that it is unfit for hard labor and for out-door vicissitudes; so it is sent to a place where it will not

be exposed to cold or hard muscular work, like a draper's shop, or to some occupation of an in-door character. By this grand, ignorant, and fatal mistake, many victims are added to the list of the phthisical class of the community.

In many in-door occupations a double mischief is at work. The patient is not only confined in an impure air, but is made also to inhale some foreign agent, present of necessity from the character of his work, and with which the air is charged.

Some sedentary occupations beget a habit of muscular inactivity. Unworked machinery always resumes work lazily, and muscles long left to a passive nutrition respond slowly to the dictation of the will. The physical inertia conquers the mental powers. Hence some patients can not be persuaded to give up their inactive pursuits, even when they have the opportunity. To prescribe to these individuals a walk of two miles a day is felt as a cruelty. Nor are these difficulties met with only in anæmic young girls, bleaching in millinery establishments, or in no establishments at all. They extend to men of various sorts: to men of letters, to men given up to sheer indolence, and to sedentary workmen, such as watch-makers, shoe-makers, and tailors.

On the other side, almost all occupations implying muscular exertion out-of-doors, without undue exposure to wet and damp, may be pursued by the consumptive as long as possible, and with advantage. Work keeps the mind occupied and in healthful tune.

I remember a patient once who, in the first stage of consumption, insisted on coming into town each morning from a considerable distance in the country, to look after his business, and to return home again in the afternoon. It mattered not that the sky looked threatening, for he was not afraid of such a trifle, although he thoroughly knew his critical condition. When expostulated with by his advisers (and, I am ashamed to say, by myself, for I was ignorant then of the truths I now state), his reply was: "My brothers and sisters have all died of consumption; they were coddled up, nursed, carried about, confined to bed, and bound in the cords of helplessness by the kindest hands, to the satisfaction of the doctor and of all concerned. But they soon died. I inherit the proclivity to the same disease, and I too shall die; I know it; but my course is different, for I have made up my mind to die in harness; I have kept at my business in resistance to all entreaties, and I am the only one of the family left." The plan adopted by this man was right; he bore the brunt of the disease for months, and is alive and occupied still.

I recommend all in whom consumption is hereditary, whose occupation is in the open air, to take to heart the motto of this man, to make up their minds "to die in harness." They will live the longer for the resolution.

At the same time, as there is a medium in all things, so is there in work and exercise. Excessive and violent muscular fatigue is next

door in injuriousness to complete muscular inactivity; and it is remarkable, in looking over tables of the occupations of consumptives, to find that, among those who are reported to have been occupied in out-door work, the majority have belonged to pursuits which imply an *extraordinary* muscular expenditure.

RULE VII. *Excessive Mental Exertion should be avoided by the Consumptive.*—It is the fate of some members of the human family, who are of consumptive taint, to have minds of a very active and laborious character. As children, these love reading, and pursuits of an intellectual kind. They are specially precocious; and admiring parents, with proud hopes as to the future of their offspring, encourage an exertion which ought ever to be kept in bounds. As these precocities grow up, their mental development runs out of proportion to the development of the body. On this, muscular labor becomes a bore, and the study or desk the only enjoyable place in life. The result is, not that the mind by its overwork directly wears out the body, but that the body is neglected, and its physical degeneration hastened.

The bad effects show themselves first, according to my observation, in derangement of the digestive system. In young persons of consumptive taint, the impaired nutrition of the whole body, incident to the impaired digestion and broken sleep, tells speedily on the respiration, and supplies the first link in the fatal disease. Let all the absurd poetry about "those dying young whom the gods love" go its way. The gods love and help those who live naturally—and these die *old*.

I have seen so much mischief arise from the overwork of the mind, in consumptive children and youths, that I have dwelt no longer than is really necessary in treating on the importance of the present rule. If I had a child of decidedly consumptive tendency, he should scarcely touch books at all. He should be taught orally as much as possible; he should be brought up in the open air, and to out-door sports and occupations; and he should be encouraged to enter into every innocent game where the muscles are brought into vigorous play.

The choice of an occupation is best made by adopting the exclusion process. Exclude every calling in which close confinement to the study, the shop, the counting-house, or any other house, absorbs the greater part of life. The agricultural life is, on the whole, the best.

Every occupation will be modified with advantage by the enjoyment of ennobling pleasures. The dance, the lecture, the drama, music, is each good in its season, when attainable without injury to health. But from all crowded assemblies I warn the consumptive to keep away. The pleasure derived from them is nothing in comparison to the evil insured in obtaining it.

Music has a grand influence on some minds, and may be cultivated with advantage under due regulations; but upon wind-instruments

the phthisical man should not exert his skill. The exertion of blowing these instruments interferes materially with the regular play of the respiration and circulation. In playing upon stringed instruments, moreover, the amusement should not be carried on until it wearies the performer. Mothers anxious for the accomplishments of their daughters make frequently a fatal mistake on this score. They place a poor child, who has no musical tastes, at the piano-forte; and there she is made to sit hour after hour, until a lesson is perforce learned, or an exercise completed. The system, useless in an educational sense, is fraught with direct danger to health.

For the consumptive, reading aloud is a good daily practice. Cuvier, the great naturalist, attributed his recovery from threatened phthisis to the delivery of some lectures which he was appointed to give. There should, of course, be a limit to the time of reading aloud; it should never exceed an hour, should be stopped if hoarseness or weariness occur, and should be without effort or vociferation.

The selection of books for the entertainment of the mind is a further and important point. Exciting romances, filled with the narrations of deep and fiendish plots or hyper-poetic sentiments, are quite out of place, for they, through the mind, influence respiration to the detriment of the physical forces of life. So also do dull, monotonous, whining, terror-striking treatises, of whatever kind. But the book which is amusing, and which, with easy effort, raises the hearty laugh at an innocent picture, or the book which carries the reader along the page of history with gentle carriage, or tells of natural facts in natural language—this is the book to be sought for.

Singing is an amusement which may with prudence be followed by the consumptive in whom the tendency to the disease is indicated only, and the disease itself is not actually developed. The exertion must not, however, be kept up so long at any given time as to produce breathlessness or hoarseness. It must be done without labor or distress, and at intervals when the body is in a condition to sustain the effort. It is then useful.

To sum up, the amusements of the consumptive should combine with the pleasure they afford a moderate and equal degree of muscular exercise, and with the muscular exercise a degree of exhilarating amusement free from over-excitement and mental toil.

RULE VIII. *Cleanliness of Body is a Special Point in the Treatment of Consumption.*—But little need be said to enforce this rule. In health there is always a mutual understanding and a kind of partnership between the skin and lungs. In consumption moderate action of the skin is a relief to the lungs, and as such ought to be encouraged. This is best attained by keeping the skin clean by daily ablution. Let the consumptive boldly take his bath as each morning comes; not a shower-bath, not a cold bath, under any impression that water cast on the body in a certain fashion, or at a certain temperature, will give

strength, but a tepid cleansing bath, with the temperature from five to ten degrees below that of the body. There is no occasion to stay in the bath a moment longer than to obtain a free ablution; then the patient should rapidly but effectually dry himself all over with a rough towel, and dress with the flannel garment undermost.

The clothes of the patient should be scrupulously clean; the underclothing should be changed every day.

RULE IX. *Abstinence from all Habits of Gross Sensual Indulgence is an Essential Part both in the Prevention and the Cure of Consumption.*—I need not particularize the vicious sensual indulgences to which many of human-kind habituate themselves; for as suggestive descriptions are better left unwritten for those who are ignorant of sensual indulgences, so for those who require to be forewarned no such descriptions are demanded, since they know too much already. In a word, I should say that, the grosser the sensuality indulged in, the greater is the physical evil resulting from it. Let the consumptive, at least, bethink themselves what vices affect and prostrate most, and then with strong mind and will give them up altogether.

To those who have charge of the young, no duty is so imperative as that of carefully watching over the physical interests. Let these make it their first care to prevent the tendency to sensual debasement. In large schools, a little attention and firmness on the part of teachers and governors, with the assistance of medical supervision, would obviate a host of life-long evils.

RULE X. *The Diet of Consumptive Patients should be ample, and should contain a Larger Proportion of the Respiratory Constituents of Food than is required in Health.*—The appetite of consumptive patients is very capricious, and daily grows more so if it be not sharpened up by exercise. When the food taken is not applied to the purposes of nutrition, it is better left untasted; for otherwise it lies undigested in the alimentary canal, and sets up a serious train of dyspeptic symptoms, nausea, and diarrhœa. Kind friends often, with the most provoking and mistaken good-nature, thrust upon the consumptive relays of the most improper food, because the necessity for nourishment is so obvious. But the fact is that, when the lungs are acting indifferently, digestion can not go on actively, since, as Arbuthnot well observed, respiration is "the second digestion." Hence the quantity of food taken by the consumptive person should be small at each meal; but the meals may, if the sensations of the patient require it, be more frequent than in health. Of animal foods, mutton is the best. Fatty and oily foods, which constitute the respiratory class, should predominate, and fresh butter, with bread, may be taken almost *ad libitum*, so long as it agrees with the stomach. Cream, too, is excellent, and the luxury of curds and cream is very suitable. Milk, whenever it suits, is advisable as a constant drink-food, and good cows' milk, new, answers every purpose. There are, as far as I can gather from numerous

cases in which I have seen them tried, no such specific virtues in asses' milk and goats' milk as some have supposed. Tea may be taken, in moderation, with perfect safety. Fresh vegetable diets should not be omitted; and fruits, especially roasted apples, are always admissible, except in instances where they excite irregular action of the bowels. The Iceland moss has had a great reputation, as have jellies of different kinds, but these often are slow in digestion, and they have no specific value.

The question of the use of alcohol in consumption is one on which scientific opinion is much divided. I have recommended alcohol under some conditions of the disease, and I have shown, on the other hand, that one particular kind of consumption may be produced by indulgence in alcohol. Of late years I have prescribed alcohol very sparingly, and never in the form of the pernicious mixtures in which it is sold for general use under the names and forms of alcoholic beverages. When I now prescribe it, it is purely as a medicine and in the form of alcohol itself properly measured, properly diluted, and properly timed. In this form it comes under the head of medicinal, as distinguished from hygienic, treatment, and, I am satisfied, with much more value than when it is inaccurately classified as a food or drink.

The two indulgences, snuff-taking and tobacco-smoking, ought to be strictly avoided by the consumptive.

Reviewing what has been thus written, I would add, as a supplement to the ten rules submitted, that, whenever distinct evidences of phthisis have set in in an individual of either sex, the marriage of such person is wrong, if not inexcusable; while the marriage of two persons, both the victims of the disease, is opposed both to reason and humanity.

Concluding Note.—The above essay "On the Hygienic Treatment of Pulmonary Consumption"—less one or two minor revisions—was written and published under the same title in 1856.

The essay found little favor. It was considered as not practical, and as conveying the ideas of a dreamer, that the fatal disease, consumption, could be prevented generally, and treated specially by hygienic measures. To-day, under a revival of the old animalcular speculation as to the origin of some diseases from living forms—the entity doctrine in a new dress—the conception of the hygienic treatment of pulmonary consumption has been accepted in name as well as practice, as if it were new in word and in deed, the height of practical learning and skill. So ideas change; and the disfavored of one generation is the favored of another. But it matters not how or by whom it is borne, so long as the torchlight of truth makes its way.—*The Asclepiod.*

TRADE DISTINCTIONS IN ALCOHOLIC LIQUORS.

By W. E. BRADLEY.

THE answer given by Mr. Dawson to the question, "Can pure, unadulterated alcoholic liquors be now obtained?" supposed to be vicariously asked by an inquiring public in his article, "How Alcoholic Liquors are made," in the May issue of "The Popular Science Monthly," would have been entirely correct if it had ended with a simple affirmation. As it stands, however, it is grossly misleading, inasmuch as it confounds substances possessing essentially different characteristics, which are universally recognized commercially by distinctive nomenclatures, and under the United States internal revenue system are controlled by different laws and regulations.

After giving a brief outline of the processes of mashing, fermentation, and distillation, which is in the main correct so far as it goes, Mr. Dawson says: "The process of rectification is generally done by redistilling, or filtering through alternate layers of woolen blankets, sand, and granulated charcoal, . . . after which process a little burnt sugar is added to give them a kind of straw-color, simply, I presume, to distinguish them from water. . . . After rectification, the spirits are gauged by the United States gauger, and a rectifier's stamp is placed upon each package, and the whisky is then ready for market, pure and unadulterated, and known as one-stamp goods. Remember that I am now stating how *good* whisky is made. . . . Therefore, if you want a pure article, purchase from a distiller or first class reliable dealer. . . . Insist that the spirit must be at least twelve months old." Merely remarking that spirits to which burnt sugar has been added would not ordinarily be called pure and unadulterated, or the addition be considered necessary to distinguish between two such dissimilar substances as alcoholic spirit and water, I make the unqualified assertion that what is above described as good whisky is not whisky at all, and never can be. This will become plain upon a consideration of some of the distinctive details in the production of rectified spirit and whisky, by which it will appear that, although the molecular changes by which starch is converted into glucose, and glucose into spirit, are the same in both cases, the subsequent treatment differs widely, with a corresponding dissimilarity in the finished product.

It is well known that in the chemical transformations which take place during alcoholic fermentation, besides ethyl or ordinary alcohol, which is the chief remaining product, certain other substances are generated which are collectively known as fusel-oil, and which may be defined as "those products of alcoholic fermentation which distill at a higher temperature than ethyl alcohol" (173° Fahr.). The principal of these is always amyl alcohol, which boils at 273° Fahr. Besides this there are butylic and propylic alcohols and volatile fatty acids, princi-

pally acetic, in variable but subordinate quantities. The fusel-oil has a pungent odor and burning taste, easily detected in the crude product of ordinary distillation. The object of the rectifier is to remove it entirely, and produce what is known commercially as "neutral" or "pure" spirit, his ideally perfect result being ethyl alcohol, chemically pure save for the water of association. It follows, therefore, that all rectified spirit being of the same character, and with a standard of quality, is a staple article of merchandise, and the great consideration with the manufacturer is to produce it with as little expense as possible, rectification being depended on to remove all offensive ingredients.

Damaged grain, which can be bought so cheaply that the low price will compensate for decreased yield and increased expense of handling, is as available as any other, provided that rectification will rectify the product. Even potatoes, which produce in fermentation such an excessive quantity of fusel-oil that amyl alcohol is commonly known as "potato-oil," are, on account of cheapness, extensively used in Germany, and so perfectly is the rectification conducted that the German pure or "Cologne" spirit is unsurpassed in quality.

When amylaceous material is boiled with a small proportion of a strong mineral acid, there results an almost perfect conversion of the starch into sugar. For this reason an attempt was made in this country several years ago, on a commercial scale, to dispense with the use of malt in the manufacture of rectified spirit by substituting sulphuric acid in the mash, and afterward neutralizing it before fermentation. Had the attempt been successful, it would, on account of the cheapness of the substitute, have caused a material reduction in the cost of the alcoholic product. It turned out, however, that the successful neutralization of the acid was difficult, and that the alcohol developed by the subsequent fermentation was so acted upon by it as to produce sulphuric ether, which, besides causing a waste of material, could not be removed economically; had this proved feasible, sulphuric acid would undoubtedly have come into general use in the manufacture of rectified spirit.

In every detail of the manufacture the same law of economy holds good; and that machinery is most popular which will accomplish the desired result with the least expenditure of time, material, fuel, and labor.

I mention these facts mainly to show that, however unpromising for a favorable result are the preliminary materials and means, rectification thoroughly conducted is relied upon as a practical remedy for all defects, and they no more detract from the character of the finished product than does the nature of its source from the purity of perfectly filtered water.

Pure or neutral spirit is largely used for the manufacture of counterfeit whisky, brandy, etc., in which the imitation is produced by the

addition of foreign substances which must be used sparingly, both on account of economy, and because their character must not be too obtrusively shown. It is plain, therefore, that the more effectively the pungent fusel-oil is removed, the better the rectified spirit will be for the purpose, as any attempt to mask its odor and taste by an excess of the flavoring materials would betray the deception by the character of the resulting products. Mr. Dawson truly says that "compounding is diabolizing," but rectification is necessarily its preliminary step.

Besides the fusel-oil, rectification also removes the essential oils which may be contained in the alcoholic distillate, naturally giving it the characteristic flavor of the original grain, rye imparting a rye-flavor, corn a corn-flavor, etc. While there is nothing necessarily injurious in these essential oils, they would nevertheless be justly considered impurities where the object in view is the production of neutral spirit, and are naturally eliminated by the mechanical means employed for rectification.

Our finished product is now as complete as it ever can be, as ethyl alcohol possesses inherently no latent quality which can develop in it a more perfect character. Even if the unusual device is adopted of storing it in a charred-oak barrel (a treatment almost universal with whisky), the resulting color and astringency will add nothing to its value, but a marked and rapidly increasing shrinkage of volume will follow, without any compensating advantage. It behooves the owner, therefore, to market it as soon as possible, and it would certainly be some especial reason which could induce him to keep it on hand for even the shortest time (twelve months) which Mr. Dawson regards as necessary for its proper development. Rectified spirit, therefore, may be described as the purified product of crude alcoholic distillation (high-wines), and as close an approximation to pure ethyl alcohol and its water of association as the mechanical means available to the rectifier will produce.

The legal definition goes still further, and includes, in the words of the statute, "any spurious, imitation, or compound liquors" manufactured by mixing distilled spirits, wine, or other liquor, with any materials for sale under the name of whisky, brandy, rum, etc. All rectified and compounded goods put up in casks are, under Government regulations, stamped with one stamp only, and are known as "one-stamp" goods.

What, then, is whisky, and especially good whisky?

Its largest proportion is of course ethyl alcohol and water, with sufficient of the essential oil of the grain to give it its distinctive grain-flavor, although this is sometimes so feebly developed as to leave its character in doubt, and deteriorate from its market value, especially in the case of rye-whisky. When new, it also necessarily contains a small quantity of fusel-oil, and it is this complex substance which gives to whisky its distinctive character as compared with other alcoholic

liquors, and, by the relative proportions of its component parts to each other and to the whole mass, eventually determines its quality. In view of the poisonous and deleterious character of fusel-oil, this statement may seem like a confirmation of the frequently expressed opinion that all whisky is essentially injurious in its physiological effect; and, indeed, the fact of its presence in immature whisky has been illogically used as one of the strongest reasons in favor of total abstinence. The argument, however, is no more consistent than would be the indiscriminate condemnation of all fruit because unripe fruit is unwholesome, and a large proportion of it never reaches maturity at all. For note the proviso, "when new." . . . Whisky, when first distilled, is entirely colorless, and, with a few local exceptions, is put up in charred white-oak barrels. The gradually deepening amber hue is imparted to it by the thin brown layer of baked wood underlying the charred surface, the charcoal itself—contrary to the general opinion—having no influence in this respect. No extraneous coloring-matter is needed, nor is any ever used by first-class distillers. A very little tannic acid is also extracted from the wood, causing a slight astringency in the liquor. By far the most important changes, however, are the chemical ones which take place in consequence of the presence of the fusel-oil, its constituent acids and alcohols acting and reacting upon each other with the production of fragrant ethers at the expense of the crude reagents, so that, in a perfectly ripened whisky, the fusel-oil should disappear, with the formation of acetate of amyl (pear-oil), butyric ether (pineapple essence), valerianate of amyl (apple-oil), œnanthic ether (Hungarian-wine oil), etc. Strange transformations these may seem at first sight; but, nevertheless, they are entirely in accordance with chemical analogy, and by no means so remarkable or complex as those by which the volatile alcohol is derived from the solid starch. The development of these fruit-essences is very slow, but may be somewhat hastened by good ventilation and the proper degree of natural heat. It is probable that there are also other subtile changes, the *rationale* of which has never been explained, but without which the result would be imperfect, as otherwise it would be fair to suppose that the same end could be attained by adding the proper fruit-essences to rectified spirit, whereas in fact the art of the compounder has never been able to produce a good commercial imitation of the genuine article.

The entire series of changes is called "aging," and to it is due the mellowness and aroma which characterize a well-ripened maturity. They can never take place in rectified spirit, as it does not contain the necessary constituents. The length of time during which good whisky will continue to improve can not be limited by any absolute number of years. It should, however, never be used when younger than from three to five years; six years old is still better, and under wise Government regulations it might come about that the usual age will not be less than that.

Too much fusel-oil is even more destructive of quality than none at all, and produces a crudeness and roughness which no lapse of time can remove. There is plenty of whisky made with just these characteristics, but not even by courtesy can it be called good; some of it, indeed, is so bad that, after a very limited time, it grows worse instead of better; such a result can come only from the carelessness or incompetence of the manufacturer, or from lack of suitable apparatus.

The great aim of the intelligent distiller is, first, to prevent excessive development of fusel-oil; and, secondly, to so arrange the details of his distillation that just the proper quantity shall appear in his distillate, and in the proper proportions. Theoretically its constituents should be possible of removal from the ethyl alcohol by ordinary distillation, in consequence of their higher boiling-points. In fact, however, certain portions are carried over mechanically at lower temperatures, and it is this fact which makes it possible, by the shape, arrangement, and manipulation of the distilling apparatus, to so control the process that, practically, none of the constituents of the fusel-oil shall be in injurious excess or deficiency, but all harmoniously proportioned to further the development of the aging-process. This partial control, however, does not relieve the fine-whisky distiller from the necessity of close attention to the preliminary steps. Good grain is absolutely necessary for the production of good whisky. Good water, scrupulous attention to cleanliness, and the most careful personal supervision, guided by long experience, are equally imperative; for, unlike the rectifier, he has no universal remedy after distillation for all defects. His product, once imperfect, must either remain so, or, by rectification, lose its character altogether.

Mr. Dawson says, either directly or by implication, that most good whisky-distillers either rectify their product themselves or that it is done in a rectifying-house. Such a gross mistake could only come from want of discrimination between the distinctive characteristics of fine whisky and rectified spirit, the former being either excluded entirely from his consideration, or else confounded with the lower grade of goods. As a matter of fact, no fine whisky is ever rectified, and from the previous description it is easily seen why such treatment is not only unnecessary, but would be positively destructive to its proper development. Neither is it ever offered for sale as one-stamp goods; why, will be easily understood when it is known that the best brands of fine whisky are worth, when new and in bond, from two to three times as much as one-stamp or rectified goods, the disparity in value increasing with age.

Explanation of the cause removes the mystery; and to the judgment of the reader, in view of the facts set forth, I leave the consideration of the propriety of using one-stamp alcoholic spirit twelve months old.

THISTLES.

By GRANT ALLEN.

THERE is no weed weedier or more ubiquitous than the common thistle. In paradise, it is true, if we may trust John Milton and the Sunday-school books—wise, as usual, beyond what is written—there were no thorns or thistles; the creation and introduction of the noxious tribe upon this once innocent and thornless earth being a direct consequence of the fall of man, and a stern retribution for Adam's delinquency. But since then the thistle has managed so to diffuse itself over the habitable globe that there hardly now remains a spot on earth without its own local representative of that ever-intrusive and conquering genus. Wherever civilized man goes, there the thistle accompanies him as a matter of course in his various wanderings. It adapts itself to all earthly environments. Close up to the Arctic Circle you find it defying the indigenous reindeer with its prickly wings; under an equatorial sky you may observe it accommodating itself most complacently with a sardonic smile to tropical existence, and battling with the prickly cactuses and the thorny acacias, to the manner born, for its fair share of the dry and arid uplands. Even nettles are nowhere in competition with it; in spite of its valuable and irritating sting, the nettle has not the plasticity and adaptability of constitution that mark the stout and sturdy thistle tribe. Garnered and harvested yearly with the farmer's corn, its seeds have been gratuitously distributed by its enemy, man, in all climates; and, when once it gains the slightest foothold, its winged down enables it to diffuse itself *ad infinitum* through the virgin soil of yet unconquered and unthistly continents. A field of thistles in England itself is a beautiful sight for the enthusiastic botanist (who has usually a low opinion of the agricultural interest); but in the fresh and fallow earth of New Zealand they attain a yet more prodigious and portentous stature, that might well strike awe and dismay into the stout heart of a Berkshire farmer.

The fact is, the thistle is one of those bellicose plants which specially lay themselves out, in the struggle for existence, for the occupation of soils where they are compelled to defend their leaves and stems from the constant attacks of the larger herbivores. On open plains and wide steppes, much browsed over in the wild state by deer or buffalo, and in the degenerate civilized condition by more prosaic cows and donkeys, one may always note that only the prickliest and most defensive plants have any chance of gaining a livelihood. Gorse and blackthorn form the central core of the little bushy clumps on our English commons, grown over thickly with bramble and dog-rose, or interspersed every here and there with occasional

taller masses of may and holly. Nay, at times even naturally undefended species assume a protective armor under such special circumstances, as in the case of the pretty little pink rest-harrow, which grows close to the ground with soft stems and leaves where unmolested by cattle, but quickly develops an erect and stiffly thorny variety when invaded by troops of cows or horses. In that case the unarmed specimens get eaten down in a short time by the browsing cattle, and only those which happen to possess any slight tendency in a prickly direction are left to occupy the stubborn soil and produce seed for the next generation. It is this unconscious selective action of the larger herbivores which has at last produced the general prickliness of all the plants that naturally frequent rich and open lowland pastures.

There are differences, however, between prickles and prickles. Some plants are positively aggressive, like the stinging-nettle; others are merely and strictly defensive, like the common thistle, whose proud motto, as everybody well knows, is "Nemo me impune lacessit." In the very doubtful Latinity of the Licensed Victualers, it goes in strictly for "Defensio non provocatio"; whereas the nettle, it need hardly be said, is often most distinctly provoking, and even goes out of its way to annoy a neighbor. This distinction I take to depend upon a difference in the acquired habits of the two races. The nettle is almost entirely a product of urban civilization; it hangs about the streets and out-houses of small villages, the neighborhood of farmyards, and the immediate surroundings of rural man. It lives in constant expectation, as it were, of being browsed upon by donkeys, or trampled under foot by cattle, or picked by children, or stubbed up root and all by the ruthless farmer. Hence its temper has become permanently soured, and it has at last developed a restless, feverish, wasp-like habit of stinging everybody who comes within arm's length of it. It is necessary to the safety of the nettle, in fact, that it should give you warning of its presence at once, and induce you to keep well away from it under pain of a serious and lasting smart. Our common English nettle, which grows everywhere along road-sides and waste places, is bad enough in this respect; but the smaller nettle—a foreign importation of more strictly civilized and urban habits, never found far from human habitations—is still crueler and more poisonous; while the South European Roman nettle, accustomed for innumerable generations to the fierce struggle against Italian civilization, has developed an advanced and excruciating sting, which beats the puny efforts of our own species into complete insignificance, as the virus of the hornet beats the virus of the hive-bee.

On the other hand, the thistle family are far more truly rural and agricultural in their habits, being denizens of the open fields and meadows, less dependent than the nettles upon richness of soil, and readily accommodating themselves to all vacant situations. Hence they have only felt the need of arming themselves in a rough-and-

ready prickly fashion against the probable assaults of their natural enemies. They have forged darts, but have not learned to poison them. Their prickly leaves and wings are amply sufficient for defense, without the necessity for developing a virulent juice to be injected into the very veins of their savage aggressors. Natural selection can never push any special line of evolution further than is imperatively called for by the wants and circumstances of the particular species. It always necessarily leaves off just at the point where the protection afforded is fully sufficient to guard the kind from the possibility of extinction. The thistles have found in actual practice that prickles alone are quite enough to secure their boasted immunity from extraneous attacks: the nettles have practically discovered for themselves that without stings they would soon be landed in the final limbo of utter nonentity.

Circumstances have still preserved for us a very tolerable series of the successive stages whereby our existing thistles have gradually acquired their present prickly and repellent characteristics. In the good old days, while evolution was still fighting hard for public recognition, it used to be urged by the uninstructed outsider that we never found any "missing links." As a matter of fact, in ninety-nine cases out of a hundred, the links are not and never were missing at all; and the practical difficulty is rather to establish any well-marked distinctions of kind than to discover long series of intermediate individuals. Just as the white man gradually merges into the negro by slow steps, when we cross Europe, Asia, and Africa, through Italians, Greeks, Levantines, Arabs, Egyptians, Nubians, Abyssinians, and true Soudanese, so the various kinds of thistles merge imperceptibly one into the other by innumerable varieties and natural hybrids. To be sure, there *are* such things as well-marked species in nature; but there are also groups which it is impossible anywhere to split up into good and distinctly different kinds. The brambles, the wild roses, the St. John's-worts, and the epilobes absolutely defy regular classification: the thistles, though perhaps a little more amenable to the subtile arts of the artificial species-maker, still constantly glide one into the other by strangely graduated intermediate forms. The great *crux* really lies in the problem of the existence of such natural gradations; for, according to the strict Darwinian principles, the better adapted and more specialized forms ought to crush out the intermediate types, and leave the species well demarkated one from the other by broad intervals. Probably the true explanation of the anomaly is to be found in the wide distribution and high adaptability of these dominant forms; they can accommodate themselves exactly to such an extraordinary variety and diversity of situations, that special intermediate types answer best in every intermediate soil or climate.

The most primitive and unarmed class of the thistle tribe is well represented by the saw-wort of our copses, a true thistly plant in all its

general appearance and habits, but absolutely devoid of thorns or prickles. The leaves, indeed, are toothed and pointed, but the points never project into fierce spines, as in the more advanced kinds; and even the little scales that form a cup for the flower-head, though faintly stiff and sharp, are scarcely if at all defensive in character. The flower, of course, is usually the first part to be specially protected, because upon it depend the future seeds and the hope of coming generations of thistles. Just as instinct teaches female animals to fight fiercely and bravely for their young, so natural selection teaches menaced plants to arm themselves stoutly against the threatening depredators of their seeds and blossoms. The reason why the saw-wort and its unarmed South European allies have managed to do without the protective inventions of their more developed relations is no doubt because they live mostly in thickets and woody places, not much overrun by cattle or horses. Their neighbors in the open meadows and pastures have been compelled long since to adopt more military tactics in order to save themselves from premature extinction. Often, indeed, in a close-cropped paddock, you will find only two kinds of tall plant uneaten by the beasts—the meadow buttercup, preserved from harm by its acrid juices, and the creeping thistle, armed all round with its long rows of parallel prickles.

In the mountains of Wales and the north of England there is yet another kind of true thistle, classed as such by technical botanists (for the saw-wort is artificially relegated to a distinct genus), which is also destitute of prickles on the leaves, though it sometimes shows the first faint beginnings of a prickly tendency around the scaly flower-cup, and in the bristly teeth of its crinkled leaves. From this early stage in the evolution of thistledom we can trace the gradual steps in the defensive process, through thistles that grow with prickly leaves, and those in which the prickly margins begin to run a little down the stem, to those which have clad themselves from top to toe in a perfect mail of sharp spines, so that it becomes quite impossible to grasp them anywhere with the hand, and they can only be eradicated by the hoe or plow. It is a significant fact that the most persistent and troublesome of all these highly developed kinds, the creeping thistle, now universally diffused by man over the globe, is a special weed of cultivation, far most frequently found in tilled fields, and seldom disputing with the simpler forms the open moors, mountains, or pastures. It does not trust entirely, like others of its kind, to its floating seeds, blown about everywhere as they are by their light tag of thistle-down; but it creeps insidiously underground for many yards together, sending up from time to time its annual stems, and defying all the attempts of the agricultural interest to exterminate it bodily by violent measures. This is the common and familiar pale purplish thistle of our English corn-fields, and there can be little doubt that it has developed its curious underground habits by stress of constant human warfare,

especially with the plowshare. Thus the very efforts we make at fighting Nature defeat themselves: if we persistently hoe down the stems and leaves of an obnoxious weed, the weed retaliates by sending out hidden subterranean suckers, and the last state of the agriculturist is worse than the first.

On the close-cropped chalk downs of our southern counties there is another curious form, the stemless thistle, which shows in another way the hard struggle of Nature to keep up appearances under the most difficult and apparently hopeless circumstances. Among the low sward of those chalky pastures, nibbled off incessantly as fast as it springs up by whole herds of Southdowns, no plant that normally raised its head an inch above the surface would have a chance of flowering without being eaten down at once by its ruthless enemies. So the local dwarf or stemless thistle has adopted a habit of expanding its very prickly leaves in a flat rosette or spreading tuft close to the ground, and bearing its blossoms on the level of the soil, pressed as tight as possible against the short turf beneath. The appearance of these three or four dwarfed and stunted but big flower-heads, bunched thickly together in the middle of their flat leaves, is most quaint and striking when once one's attention is called to their existence: yet so unobtrusive and unnoticeable is the entire plant that few people save regular botanists ever discover the very fact of its presence on the chalk downs. It is only one out of a large group of specialized chalk plants, all of which similarly creep close to the ground, while a few of them actually bury their own seeds in the soil by a corkscrew process, so as to escape the teeth of the all-devouring sheep. The power of producing a stem, however, is rather dormant than lost in the dwarf thistle, for under favorable circumstances and in deep soil it will raise its flowers eight or ten inches above the surrounding turf.

The question what particular plant ought to be identified with the stiff, heraldic Scotch thistle has long been debated, somewhat uselessly, it must be acknowledged, among botanists and antiquaries. For heraldry is not particular as to species and genus: it is amply satisfied with a general rough resemblance which would hardly suit the minute requirements of those microscopical observers who distinguish some forty kinds of native British blackberries. However, it has been amicably decided in the long run that the heraldic symbol of Scotland, that proud plant which no man injures unavenged, is not to be considered a thistle at all, but an onopord, a member of a neighboring though distinct genus, whose Greek name expressly marks it out as the favorite food of—how shall I put it with becoming dignity?—the domestic beast of Oriental monarchs. To what base uses may we come at last! The royal emblem of the north, as identified by Mr. Bentham and other profound authorities, is now at last settled to be nothing more nor less than the cottony donkey-thistle. North

of the Tweed this identification should be mentioned, as French newspapers remark, under all reserves.

Almost all the thistles have purple florets, and purple, it may be safely assumed, is the primitive color of the whole thistle-head tribe. Some of them, indeed, fade off gradually into pink and white; but such reversion to a still earlier ancestral hue is everywhere common and easily brought about by stress of circumstances. The thistles in the lump are composites by family, and the apparent flower is really a flower-head, containing an immense number of small, bell-shaped, five-petaled florets, with the petals united at their base into a deep tube. The honey rises high in the throat within, and is sucked chiefly by bees and burnet-moths, who form the principal fertilizers of the entire group. Purple is the favorite color of these advanced flower-haunters, and it seems probable that all the purple blossoms in nature have been evolved by their constant and long-extended selective action. Nothing can be more interesting than to watch a great burly humble-bee (one of the large black sort) bustling about from flower-head to flower-head of the pretty, drooping, welted thistle on a bright summer's day, with his proboscis constantly extended in search of food, and unconsciously carrying the pollen-grains about his head and legs from the florets of one blossom to the sensitive surface of the next in order.

After the flowers have been duly fertilized, the thistle-seeds begin to swell, and the down around them to grow dry and feathery. This down, so familiar to all of us among the autumn fields, has doubtless played no small part in the dispersal of the thistles. It is to their floating seeds (or rather, to be strictly accurate, their fruits) that the entire family owe a great part of their existing vogue and unpopularity. In almost all the composites the tiny calyx grows out into much the same silky down on the ripe fruit, but in hardly any other case, save perhaps those of the dandelion and the common sow-thistle, does it form so light and airy a floating apparatus as in the true thistles. Wafted about on the wings of the wind, the thistle-down is blown easily hither and thither, alighting everywhere, far and near, and finding out fresh spots for itself to root and thrive on every side. Not only does this plan insure the proper dispersal of the seeds, however: it also provides for that most important agricultural need, the rotation of crops. Long before scientific farming had hit upon the now familiar rotatory principle, hundreds and hundreds of plants in the wild state had worked it out practically for themselves under stress of the potent modifying agency of natural selection. For thistles can no more grow on the same spot for an indefinite number of generations than corn or turnips can; they require to let the soil on which they live lie fallow for a while from time to time, or be occupied by other and less exhausting crops. Hence it follows that in nature innumerable means exist for favoring or insuring the dispersal

of seeds; or, to speak more correctly, only those plants in the long run succeed in surviving which happen to possess some such facility for constant rotation and occupation of fresh districts.

It is very interesting in this respect to compare the devices for the distribution of their seeds in some of the thistle's own nearest and best-known relations. The burdock, for example, is in flower and fruit almost a thistle, though it differs considerably from the thistles proper in its large, broad, heart-shaped foliage. But the burrs, or ripe flower-heads, instead of being surrounded, thistle-fashion, by a very defensive prickly involucre, have developed instead hooked points to their bracts, which catch at once at the wool of sheep, the legs of cattle, and the dresses or trousers of wayfaring humanity. In this way the entire head of seeds gets carried about from place to place, and rubbed off at last against a hedge or post (at least by its unwilling four-footed carriers), where it forms the nucleus of a fresh colony, and starts in life under excellent auspices, especially if dropped (as it is apt to be) in the immediate neighborhood of a well-manured farm-yard. Hence the burdock has no further need for the down which it inherits, like all its tribe, from some remote common ancestor; it has substituted a new and more practically effective system of transport *en bloc*, for the old general composite mode of dispersal in single seeds by a feathery floating apparatus. Accordingly, the pappus, or ring of down, though it still exists as a sort of dying rudiment on each fruitlet of the burrs, is reduced greatly in size and expansion, and consists of a mere fringe of short, stiff hairs, useful perhaps in preventing flies from laying the eggs of their destructive grubs upon the swelling seeds. In the common knap-weeds, again, which wait for a high wind to shake out their seeds from the head, this dwarfing of the down has proceeded much further, so that at first sight a careless observer would never notice its existence at all: but if you look close at the ripe fruit with a small pocket lens, you will observe that it is topped by a ring of very minute, scaly bristles, occasionally mixed with a few longer and hairier ones, which are all that now remain of the once broad and feathery down. Among the true thistles, on the other hand, which trust entirely to the gentle summer breezes for dispersal, and which float away often for miles together, innumerable gradations of featheriness exist, some species having the down composed of long, straight, undivided hairs; while in others of a more advanced type it consists of regular feathered blades, barbed on either side with the most delicate beauty. Almost all our commonest and most troublesome English thistles belong to this last-named very feathery type, whose seeds are, of course, enabled to float about on the wind far more readily and to greater distances than the simple-haired varieties.

The thistle pedigree is a long and curious one. The group forms, apparently, the central and most primitive existing tribe of the composite family, and it bears in its own features the visible marks of a

vast previous evolutionary history. Starting apparently from blossoms with five distinct and separate yellow petals, like the buttercups, the ancestors of thistlehood gradually progressed, as it seems, by insect selection, to a condition something like that of the harebell or the Canterbury bell, in which the petals have coalesced at their bases into a single large and united tube. Clustering together next into closely serried heads, like those of the scabious, the rampions, and the common blue sheepsbit, they endeavored to make up for the individual minuteness of their dwarfed flowers by the number and mass collected in a group on the summit of each stem. In this way they gradually assumed the distinctive crowded composite form, each floret consisting of a tubular five-lobed corolla, a calyx reduced to hairs or down, and single tiny seed-like fruit. Of this stage in the development of the family, the simpler and less specialized members of the thistle group, such as the unarmed saw-worts and the Alpine saussurea, are now the best surviving representatives. From some such early central form, the evolving composites split up and diversified themselves into all their astonishing and almost incredible existing variety. Some of them, varying but little in minor details from the parent stock, acquired prickly leaves and grew into the thistle kind, or developed hooked and sticky involucres, and were known as burdocks. Others, producing at their edge a row of brilliantly colored and attractive florets, which serve the purpose of petals for the compound head, branched off into all the marvelous wealth of daisies, asters, sunflowers, marigolds, dahlias, golden-rods, ox-eyes, and cinerarias. In yet others the whole mass of the florets, central as well as external, has assumed this ray-like or strap-like form ; and to this group belong the dandelions, hawk-weeds, salsifies, lettuces, sow-thistles, chiccories, nipplewort, and cat's-ears. By far the most successful of all flowering plants, the composites have taken possession in one form or another of the whole world ; and among the entire wealth of their extraordinary diversity there is no group more universally fortunate than the common thistle. What from the purely agricultural point of view we describe as a very persistent and almost ineradicable weed, from the higher biological point of view we should more properly regard as a dominant and admirably adapted species of plant. The one conception is merely narrow, practical, and human ; the other is positive, philosophical, and universal.—*Longmans' Magazine.*

INEBRIATE MANIACS.

By T. D. CROTHERS, M. D.

PSYCHOLOGISTS and students of mental science have long been aware of the presence of a new division of the army of the insane, a division which is steadily increasing, more mysterious and obscure than the ordinary insane, and constituting a new realm of the most fascinating physiological and psychological interest. It consists of the alcoholic, opium, chloral, ether, and chloroform inebriates. They appear in law courts, as both principals and associates in all degrees of crime, and are called drunkards, tramps, and dangerous classes. In conduct, character, and motive, they constantly display many prominent symptoms of insanity, such as manias, delusions, deliriums, and imbecilities. Yet public opinion refuses to recognize these symptoms, because they are associated with intervals of apparent sanity in act and conduct. Clergymen and moralists teach that these cases are simply moral disorders, growing out of "a heart deceitful and desperately wicked," and only remedied by moral and legal measures. Scientists, who study the history and progress of these cases, find that they are diseases, following a regular line of march, from definite causes, on through certain stages of growth, development, and decline, the same as in other maladies.

Many theories are urged to explain the presence of this army of inebriates; one of which asserts that inebriety is evidence of the moral failure of the age, of the increasing wickedness of the times, of the triumphs of the growth of evil over the good, etc. Another theory assumes that the great increase in the manufacture of all forms of alcohol and other drugs, and the facility with which they are procured, will fully explain the presence of this class. A third theory considers them the defective, worn-out victims of this crushing, grinding civilization; the outgrowths of bad inheritance, bad living, and the unfit generally, who are slowly or rapidly being thrown out of the struggle. A fourth view regards them as simply coming into prominence, through the great advances in the physiology and pathology of the brain and nervous system, in which the physical character of these cases is recognized.

Inebriate maniacs have been called "border-land" lunatics, meaning persons who move up and down on the border-line between sanity and insanity, and, when studied closely, divide naturally into many classes. One of these classes, which in most cases represents extreme chronic stages, appears prominently in the daily press, in reports of criminal assaults and murders. When the genesis of the crime and the so-called criminal are studied, unmistakable symptoms of mental

unsoundness appear. In most cases the victim is a neurotic by inheritance and growth. In other words, he was born with a defective brain and organism, and both growth and culture have been imperfect. Many and complex influences, among which alcohol or other narcotics may be prominent, have prepared the soil, furnished the seed, and stimulated the growth of a positive disease of the brain. The higher brain-centers have slowly succumbed to a paralysis, as mysterious as it is certain in its march. The victim's capacity to comprehend his condition, and adjust himself to the surroundings, becomes less and less, and he is more and more a waif drifting with every possible influence. In appearance, head, face, and body are angular and imperfectly developed, the nutrition is defective, the eye, the voice, and every act and movement indicate degeneration and disease. Any general history of the crime reveals delirium, hallucinations, delusions, and maniacal impulses. Thus, in one day, the papers recorded the following among other cases of this class: An inebriate, of previously quiet disposition, killed his wife, supposing she had put poison in his food. Another man in a similar state shot a stranger who differed with him on the age of Queen Victoria. Another man killed his father, who remonstrated with him for overdriving a horse. Still another assaulted fatally his brother, who would not give him money. Two men, both intoxicated, mortally wounded each other in a quarrel who should pay for the spirits drunk. Another man killed both wife and child, supposing the former was going to desert him. Thus, day after day, the records of these inebriate lunatics appear, and each case is as positively the act of a maniac as if committed by an inmate of an asylum, whose insanity was long ago adjudged. In each case, a long premonitory stage has preceded this last act; the individual history of almost every inebriate furnishes abundant evidence of this. In the court-room this insanity of the prisoner is ignored, and the legal fiction, that drunkenness is no excuse for crime, prevails. The prisoner is assumed to be always a free agent, and the use of alcohol a willful act, the consequences of which he should be held accountable for. As a result, the victim is destroyed, and the object of the law, to reform the offender and deter others from the commission of crime, lamentably fails.

The second class of these inebriate maniacs are less prominent in the press, but more often seen in the lower and police courts. They are arrested for drunkenness, minor assaults, and all grades of breaches of the peace. They use alcohol, opium, or any other drug for its effect, and their character and conduct are a continuous history of insane and imbecile acts. In appearance they are suffering from disease, and the hereditary history is prominent in ancestral degenerations and defects. They are repeaters for the same offense over and over again, and their crime is of a low, imbecile type against both person and property, characterized by profound mental and moral paralysis. In popular esti-

mation they are simply armies of vicious, wicked persons, who are so from love of the bad and free choice of evil. This idea prevails in the court-room, and the judge, with a farcical stupidity, admonishes, rebukes, and sentences these poor victims, who are supposed to be made better by the moral and physical surroundings of the prison, and the sufferings which the vengeance of the law inflicts. The case may have appeared many times before for the same offense, and the act committed may have been particularly insane and motiveless, and yet the judge deals out justice on the legal theory that the prisoner is of sound mind, and fully conscious and responsible. The result is clearly seen in the records of police courts, showing that the number of persons who are repeatedly arrested for drunkenness is increasing. Another result more startling, but equally true, appears. Every law court where inebriate maniacs are tried and punished, on the theory that drunkenness is no excuse for crime, and that the victim should be treated as of sound mind, with free will to do differently, is a court of death, more fatal than all the saloons and beer-shops in the world. Such courts destroy all possibility of restoration, and precipitate the victim to lower grades of degeneration. It has been estimated that ninety-nine out of every one hundred men who are arrested for drunkenness for the first time, and sentenced to jail, will be returned for the same offense within two years, and appear again with increasing frequency as long as they live. The report of the hospital at Deer Island, near Boston, where drunkards are sent on short sentences, for 1883, showed that one man had been sentenced to this place for the same offense, drunkenness, seventy-five times. Before the temperance committee of the English Parliament, in 1882, many cases were cited of men who had been sent to jails and work-houses from twenty to two hundred times for drunkenness. Practically, every sentence for drunkenness for ten, thirty, or sixty days, costs the tax-payers from fifty to one hundred and fifty dollars; and more completely unfits the victim for and removes him from the possibility of living a temperate, healthy life. Enthusiastic temperance men have drawn the most startling conclusions from these lower court records of arrests for drunkenness. Here each arrest stands for a new man and case. The nine thousand cases recorded as having been sent to Deer Island in 1883 in reality only represent a little over two thousand different men and women, and yet the number of arrests is taken as evidence of the increase of drunkenness.

A third class of inebriate maniacs are less common, and yet they often come into great notoriety from some unusual act or crime. They are known as moderate or occasional excessive users of alcohol; or opium and chloral takers. In most cases they are from the middle and better classes of society, and are beyond all suspicion of insanity, and their uses of these drugs are considered mere moral lapses. Such persons will suddenly exhibit great changes of character and conduct,

and do the most insane acts, then resume a degree of sanity that corresponds with their previous character. Thus, a prominent clergyman of wealth and high standing in the community, who was a wine-drinker, suddenly began a series of Wall Street speculations of the most uncertain, fraudulent nature. He implicated himself and a large number of friends, and finally was disgraced. A judge, occupying a most enviable position of character and reputation, who had used spirits and opium for years at night for various reasons, suddenly gave up his place and became a low office-seeker—was elected to the Legislature, and became prominent as an unscrupulous politician. A New England clergyman, after thirty years of most earnest, devoted work, renounced the church and became an infidel of the most aggressive type. Later it was found that he had used chloroform and spirits in secret for years. A man of forty years, of tested honesty and trustworthiness, proved to be a defaulter. It was ascertained that he used choral and opium in secret.

Hardly a year passes that bank defaulters, forgers, and swindlers do not appear among men whose previous character has given no intimation of such a career. When their secret history is ascertained, the use of alcohol, opium, and other drugs is found to be common.

Another class of previously reputable, sane men suddenly commit crimes against good morals. The unusual boldness of their acts points to insanity, and it is then found that they are secret or open drinkers, using alcohol or compounds of opium. Such men come into politics with a most insane ambition for office and childish delirium to appear in public as great men. They often become enthusiastic church and temperance men, acting along very unusual lines of conduct, and doing unusual things. Signs of mental failure are clearly traced in the childish credulity, or extraordinary skepticism, or extreme secretiveness, which are all foreign to the history of their past. Then, at last, such men leave strange wills, with strange bequests. They are contested; the expert is called in; and, while he is certain of insanity and irresponsibility of the testator from the history, he can not make it appear clearly to the court. These cases are more or less familiar to every one, yet the history of drinking or using narcotics is concealed. In an instance of recent date, the will of a very rich man contained a large bequest to the Freedman's Bureau. This was a very strange and unusual act; but the heirs, rather than expose the secret drinking of the testator, let the will stand. To history this was a very generous deed, but in reality it was the mere freak of a maniac.

These persons appear to all general observation sane and fully conscious of the nature and character of their acts; yet they are in a state of intellectual delirium and instability, which comes out prominently in the strange, unusual conduct. The co-ordinating brain-centers are

so damaged as to prevent healthy, consistent, uniform brain-action. A certain range of thought and action may seem sane, but an ever-increasing undercurrent of disease carries them further from normal brain-health. These cases excite the wonderment of the hour, and to moralists are phases of human depravity; but to the psychologist are explosions of masked diseases almost unknown and undiscovered.

It will be apparent to all that the most unfortunate treatment with miscarriage of justice is meted out to these cases. Thus, the inebriate maniac in delirium who commits murder and assault is not a criminal to be cured by punishment. His brain has broken down and needs the most careful restorative treatment. He is physically sick, and can never recover except by the use of well-directed remedies and along the line of exact laws and forces.

In the second class, the profound failure of the present methods of management should direct attention to the real means of cure. Science shows, beyond all doubt, that a system of work-house hospitals, where all these cases can come under exact physical care and restraint, and be organized into self-supporting quarantine stations, will not only protect the community and tax-payer, but put the victim in the best condition for permanent recovery. Here he can be made a producer, and taken from the ranks of consumers and parasites of society. If he is an incurable, he can be made self-supporting, and society and the world can be protected from his influence.

In the third class, when public opinion recognizes that the occasional or continuous use of alcohol or other narcotics is dangerous and likely to produce grave mental disturbance, these alterations of character and conduct will be no mystery. Such men will be recognized as diseased, and come under medical care and recover. Medical and scientific men must teach the world the nature and character of alcohol, and the diseases which are likely to come from its use. This moralists, clergymen, and reformed inebriates, can never do. To-day these inebriate maniacs appeal for recognition and sympathy from many homes and firesides. They call for help. They ask for bread. We are deaf to their entreaties—we give them stones. In language that can not be mistaken, they tell us of unstable brain-force, of tottering reason, of marked, insidious disease. We call it vice, and treat them as of sound mind and body. They ask for help for the brain, starved, disorganized, and growing feebler. We give them the pledge and prayer, and taunt them as vile, and willful, and wretched sinners. What wonder that the glimmerings of reason and the lights of a higher manhood should disappear in the darkness of total insanity under such treatment? In the delirium of criminal assault, or the imbecilities of the low drunkard, or the strange acts and changes of

character in the so-called moderate drinker, they mutely appeal for aid, and we brutally fine, imprison, and persecute them. These are the spirit and theory which seek support through temperance efforts, through the church, and political parties, to remove an evil of which they have no comprehension. When all this thunder and roar of temperance reformation shall pass away, the still small voice of Science will be heard, and the true condition of the inebriate and the nature of his malady will be recognized.

SKETCH OF PROFESSOR EDWARD S. HOLDEN.

By WILLIAM C. WINLOCK.

PROFESSOR EDWARD SINGLETON HOLDEN, the President of the University of California, and Director of the Lick Observatory, was born in St. Louis, Missouri, on the 5th of November, 1846. He is a direct descendant of Justinian Holden, who came to this country from Kent, England, in 1636, and settled in Massachusetts on a tract of land which now forms a part of the city of Cambridge, but was then called, I believe, Watertown. Dr. William Holden, grandson of Justinian Holden, and Professor Holden's great-grandfather, afterward moved from Cambridge to Dorchester, Massachusetts, where the family resided till about 1830. The first eight years of Professor Holden's life were spent in St Louis, but about 1854 he was taken to Cambridge and placed at the private schools taught by Miss Ware and Miss Harris. It was during the six years spent here that he received his first idea of astronomy—from his cousin, Professor George P. Bond, then Director of Harvard College Observatory—and a certain occasion upon which he first saw the bright star *a* Lyræ through the fifteen-inch telescope made a lasting impression upon his mind.

In 1860 Holden returned to St. Louis and entered the preparatory academy of Washington University, from which, after two years' study, he passed into the Scientific School of the university. The young student soon attracted the attention of Professor Chauvenet, the accomplished mathematician and astronomer, then Chancellor of the University. Professor Chauvenet spent the winter of 1864–'65 in Minnesota for the benefit of his health, and during this time Mr. Holden formed a part of his household, and prosecuted his studies directly under Professor Chauvenet's eye.

In 1866 we find him assisting Dr. Gould in collecting the statistics of the United States volunteer soldiers from the State of Missouri, for the "Investigations in the Military and Anthropological

Statistics of American Soldiers," published by the United States Sanitary Commission, and in the same year he graduated with distinction from the Scientific School, receiving the degree of B. S. While at the university he also went over an important part of the classical course.

With a view of continuing his mathematical studies, he secured an appointment to the Military Academy at West Point through the Hon. J. W. McClurg, Representative of the Fifth Missouri District in Congress, and was admitted as a cadet to the Academy on the 1st of September, 1866. On the 15th of June, 1870, he was graduated, third in a class of fifty-nine members, and was appointed Second-Lieutenant of the Fourth United States Artillery. He was assigned to Company G of that regiment, and served with his command at Fort Johnston, North Carolina, until August, 1871, when he was ordered to duty at the Military Academy, West Point, as Assistant Professor of Natural and Experimental Philosophy. June 10, 1872, he was transferred to the Engineer Corps of the army, remaining at West Point, however, as instructor in practical military engineering.

During these few years at the Military Academy he published, in the "American Journal of Science," his first astronomical work—a short paper on the "Spectrum of the Aurora" and another on the "Spectrum of Lightning."

In March, 1873, Lieutenant Holden resigned his commission in the army, and was appointed Professor of Mathematics in the United States Navy, a position which his teacher Chauvenet had held before him. He was ordered to the Washington Naval Observatory, then under the direction of Rear-Admiral B. F. Sands, and his first duties in his new profession were as assistant to Professor Harkness in the work of the transit circle. Immediately, however, upon the completion and mounting of the twenty-six-inch equatorial—at that time the largest refractor in the world—he was transferred, November 15, 1873, to duty as assistant to Professor Newcomb, who had been placed in charge of that instrument.

The results of Professor Holden's work during six years of observation with this instrument, first as assistant to Professor Newcomb, and afterward as assistant to Professor Hall, have been printed in the volumes of the Observatory publications and in various astronomical journals. Turning over the files of the "Astronomische Nachrichten" for these years, we find numerous observations of comets and of double stars, of the satellites of Uranus and Neptune, and of the companion of Sirius; but, besides all this rather prosaic routine work, Professor Holden devoted himself zealously to the more fascinating study of the physical features of the planets and nebulæ. His most elaborate investigation in this field is given in the

"Monograph of the Central Parts of the Nebula of Orion," an exhaustive *résumé* and discussion of all the observations hitherto made on the central parts of this interesting nebula. Professor Holden's own observations were made with the twenty-six-inch equatorial from 1874 to 1880, their main object being to provide sufficient data to determine with certainty in the future whether or not changes have occurred in the nebula. His conclusion, from a thorough discussion of the large mass of material already available in the observations of two hundred and twenty-four years, is briefly, that "the figure of the nebula of Orion has remained the same from 1758 to now (if we except a change in the shape of its apex (E) about 1770, which appears quite possible); but that in the brightness of its parts undoubted variations have taken place, and that such changes are even now going on."

In June, 1876, Professor Holden went to London, under instructions from the Secretary of the Navy, to examine and report on the South Kensington Loan Collection of Scientific Instruments, giving especial attention to improvements in astronomical and geodetic instruments. An interesting portion of the report (which may be found in full in the report of the Secretary of the Navy for 1876) is that relating to the system of time-signals, etc., in use in foreign countries. Considerable attention was also given to methods of testing chronometers. The time-ball on the Western Union Telegraph Building in New York was erected according to his plans in 1879.

Professor Holden observed the transit of Mercury of May 6, 1878, in co-operation with his friend Dr. Henry Draper, at the latter's private observatory at Hastings; and later in the same year he was put in charge of a party to observe the total solar eclipse of July 29th. The station selected was Central City, Colorado, an altitude of some 8,400 feet above sea-level. Professor Holden's special work was the examination of the sky about the sun for the detection of the hypothetical planet Vulcan—a search which, as we know, was fruitless. In 1879 he took charge of the library of the Naval Observatory, and in 1880 he was transferred from duty with Professor Hall to duty on the transit circle with Professor Eastman, taking part in the observations with this instrument in addition to his work as librarian. His connection with the library is marked by several valuable contributions to astronomical bibliography, notably "A Subject-Index to the Publications of the United States Naval Observatory, 1845–1875," an "Index Catalogue of Books and Memoirs relating to Nebulæ and Clusters," and a work undertaken in connection with Dr. Hastings, "A Synopsis of the Scientific Writings of Sir William Herschel."

Upon the death of the distinguished astronomer, Professor James C. Watson, Professor Holden accepted the position thus made vacant, of Professor of Astronomy in the University of Wisconsin and Direct-

or of the Washburn Observatory; and obtaining, at the request of Governor Washburn, a leave of absence from the Naval Observatory, February 2, 1881, he immediately proceeded to Madison to take charge of the observatory, which was then in an entirely unfinished state: his official connection with the navy was not severed till June 1, 1882. Professor Holden's five years of administration of the Washburn Observatory have established it in the foremost rank of American observatories. Four volumes of publications have been issued, the last one containing the most important piece of work of the Repsold meridian circle, the determination of the positions of the 303 fundamental stars for the southern zones of the "Astronomische Gesellschaft"; to form, however, an adequate idea of the varied labors of the director and his assistants, reference must be made to the volumes themselves. In 1883 Professor Holden's work at Madison was interrupted for several months, to conduct the Government expedition to Caroline Island in the South Pacific mid-ocean, for the purpose of observing the total eclipse of the sun on May 6th. Professor Holden's chosen task was again, as in 1878, the search for intra-Mercurial planets, and with the exceptionally long duration of totality—nearly six minutes—this search was made under most favorable circumstances, and again resulted negatively. The account of this expedition, contained in an interesting memoir of the National Academy of Sciences, will be found to be "much more than a technical report on the dry scientific details of the work of eclipse-observers": it includes an entertaining narrative of the ocean-voyage of twenty-nine days from Callao, and a complete history and description of the lonely little island, with photographic views of the characteristic vegetation and reef-beeches.

Professor Holden's resignation of the chair of Astronomy at Madison took effect on the 1st of January, 1886, upon his acceptance of his present position, the presidency of the University of California, and directorship of the Lick Observatory. Since 1874 he has been one of the chief consulting astronomers to the Lick trustees, who, under the provisions of the will, have charge of building and equipping the observatory. In 1881 he visited Mount Hamilton and successfully observed the transit of Mercury; in 1883 he visited it again, and in 1884 he went out again to superintend the erection of the fine Repsold meridian circle. The Lick Observatory, as it approaches completion, has received so much attention in scientific and popular journals, that a description of it seems hardly necessary here. The giant thirty-six-inch objective—through which "the observer might expect to see the moon much the same as he would without the telescope if it were only a hundred miles away," and might make out objects on the moon's surface "although they were no larger than some of the larger edifices on the earth"—is now in a fair way to be finished by the Clarks during the autumn of the present year; the steel dome will probably be finished about the

same time, and the telescope tube, which is being made by Messrs. Warner and Swasey, of Cleveland, will be ready in June, 1887. The trustees only await the mounting of this instrument, to turn over the observatory formally to the University of California. Meanwhile the observatory, as it now stands, with a twelve-inch Clark equatorial, a six-inch equatorial, a six-inch Repsold meridian circle, photographic instruments, clocks, chronometers, and all accessory apparatus, and an extensive library, is far better equipped than most observatories, and Professor Holden, with characteristic energy, has already begun an extensive series of observations with the meridian instrument, and has established a time-service for the benefit of the railroads connecting with San José.

This brief sketch merely attempts to outline Professor Holden's career as an astronomer. His administrative experience and ability were proved at Madison, and as a teacher he seems to have shown the rare faculty of arousing the enthusiasm of his pupils. His general interest in many matters outside of his profession may be seen by a glance at the partial list of his writings which is appended. This bibliography I have made tolerably full, though by no means exhaustive; I have found nearly one hundred papers, etc., contributed to scientific journals and transactions between the years 1873 and 1886; and the titles that I have given will form in themselves an effective "sketch" of his work. His life of Sir William Herschel should be referred to especially: it has been published in London as well as in New York, and has also been translated and published in Germany. A text-book of astronomy, published in co-operation with Professor Newcomb, has likewise been favorably received, and has passed through several editions.

In 1879 Professor Holden received the degree of A. M. from his alma mater, and the University of Wisconsin has just conferred the degree of LL. D. on its former professor. He is a member of the California and Wisconsin Academies of Science, Fellow of the American Association for the Advancement of Science, member of the Philosophical Society of Washington, and of the German Astronomische Gesellschaft, Corresponding Member of the Academy of Science of St. Louis, Associate Fellow of the American Academy of Arts and Sciences, Foreign Associate of the Royal Astronomical Society, and member of the National Academy of Sciences. While at Madison he was connected with Professor Raphael Pumpelly's Northern Transcontinental Survey, as head of the Division of Climate and Rivers, and in 1885 he served as a member of the Board of Visitors to the United States Military Academy at West Point.

Professional and other Papers by E. S. Holden (in general chronological order).

No.	Title.	Place and date of publication.
1	On a New Arrangement of Shutters for a Dome for an Equatorial Telescope.	Am. Jour. Sc., 3 s., 6: 375–377 (Nov., 1873).
2	On the Adopted Value of the Sun's Apparent Diameter.	Bull. Phil. Soc. Wash. 1 (App. 1): 3–9 (Jan., 1874).
3	On Sir William Herschel's Observations of the Satellites of Uranus.	Bull. Phil. Soc. Wash. 1 (App. 4): 30–36 (June, 1874).
4	Telescopic Research on the Nebula of Orion. (Illustrated.)	Pop. Sc. Month., 5: 257–268 (July, 1874).
5	On the Inner Satellites of Uranus.	Proc. Am. Ass., 23: 49–56 (Aug., 1874; Month. Not. Roy. Astron. Soc., 35: 16–22 (Nov., 1874).
6	On the Possible Periodic Changes of the Sun's Apparent Diameter [by Newcomb and Holden].	Am. Jour. Sc., 3 s., 8: 268–277 (Oct., 1874).
7	On the Number of Words used in Speaking and Writing.	Bull. Phil. Soc. Wash. 2 (App. 6): 16–21 (Jan., 1875).
8	Drawing of the Ring Nebula in Lyra.	Month. Not. Roy. Astron. Soc., 36: 61–69 (Dec., 1875).
9	[Progress of Astronomy in 1876.] [*Note.*—This annual review of astronomy is continued in Professor Baird's Annual Record for 1877 and 1878, and subsequently in the Smithsonian Reports.]	Ann. Rec. Sc. and Indust., 1876, pp. xvii–xxvi.
10	Report upon the Astronomical Instruments of the Loan Collection of Scientific Instruments at the South Kensington Museum, 1876.	Rept. Sec. Navy, 1876, pp. 289–314.
11	The Horseshoe Nebula in Sagittarius. (Illustrated.)	Pop. Sc. Month., 8: 269–281 (Jan., 1876).
12	On Supposed Changes in the Nebula M. 17.	Am. Jour. Sc., 3 s., 11: 341–361 (May, 1876).
13	Comparison of the Washington Observations of the Satellite of Neptune with Newcomb's Tables.	Astron. Nachr., 88: 183–188 (July, 1876).
14	On Reference Catalogues of Astronomical Papers and Memoirs.	Bull. Phil. Soc. Wash., 2: 95–101 (Dec., 1876).
15	Index-Catalogue of Books and Memoirs relating to Nebulæ and Clusters, etc.	Washington, 1877, 9+109+[2] p. 8°. (Smithsonian Misc. Coll., vol. 14).
16	Observations of the Satellites of Neptune and Uranus, and of the Companion of Sirius.	Astron. Nachr., 90: 161 (July, 1877).
17	[Observations of Comets *a*, *b*, *c*, 1877.]	Astron. Nachr., 90: 167, 170, 331 (1877).
18	On the Proper Motion of the Trifid Nebula. (Illustrated.)	Am. Jour. Sc., 3 s., 14: 433–458 (Dec., 1877).
19	Index-Catalogue of Books and Memoirs on the Transits of Mercury.	Cambridge, 1878. 6 pp., 8°. (Lib. Harv. Univ. Bibliog. Contrib., No. 1).
20	Note on the Reticulated Forms of the Sun's Surface.	Am. Jour. Sc., 3 s., 16: 346 (Nov., 1878).
21	A Subject-Index for the Publications of Observatories.	Library Jour., 3: 365 (Dec., 1878).
22	Catalogue of the Library of the United States Naval Observatory. Part I, Astronomical Bibliography.	Washington, 1879. 10 pp. 4°.
23	A Subject-Index to the Publications of the United States Naval Observatory, 1845–1875.	Washington, 1879. 74 pp. 4°. (Washington Observations, 1876, App. I.)
24	Reports of Observatories, 1879.	Smithsonian Rep., 1879, p. 455–512
25	The Cipher Dispatches.	Internat. Rev., 6: 405–424 (April, 1879).
26	Astronomy for Students and General Readers [by Newcomb and Holden]. (Illustrated.)	2d ed. New York, 1880. 11 + 512 pp. 8°.
27	Note on a Relation between the Colors and Magnitudes of the Components of Binary Stars.	Am. Jour. Sc., 3 s., 19: 467–472 (June, 1880).
28	On the Treatment of Pamphlets in Special Libraries. (Illustrated.)	Library Jour., 5: 166 (June, 1880).
29	On some of the Consequences of the Hypothesis recently proposed, that the Intrinsic Brilliancy of the Fixed Stars is the same for each Star.	Proc. Am. Ass., 29: 137–151 (Aug., 1880).
30	Sir William Herschel: his Life and Works.	New York, 1881. 6 + 238 pp. (Portrait.) 12°.

Professional and other Papers by E. S. Holden (in general chronological order) —(continued).

No.	Title.	Place and date of publication.
31	A Synopsis of the Scientific Writings of Sir William Herschel [by Holden and Hastings].	Washington, 1881. 114 pp. 8°. (From Smithsonian Rep.,1880.)
32	Reports of Observatories, 1880.	Washington, 1881. 126 pp. 8°. (From Smithsonian Rep.,1880.)
33	An Account of Recent Progress in Astronomy (for the Years 1879 and 1880). [*Note.*—Similar reviews will be found in the Smithsonian reports for 1881, 1882, 1883, and 1884.]	Washington, 1881. 37 pp. 8°. (From Smithsonian Rep.,1880.)
34	Studies in Central American Picture-Writing. (Illustrated.)	1st Ann. Rept. Bureau Ethnol. Smithson. Inst., pp. 207-245 (1881).
35	Investigation of the Objective and Micrometers of the 26-inch Equatorial constructed by Alvan Clark and Sons.	Washington, 1881. 44 pp. 4°. (Washington Observations, 1877, App. I.)
36	The multiple star Σ 748.	Washington, 1881. 22 pp. 4°. (Washington Observations, 1877, App. II.)
37	List of Red Stars observed at the Washburn Observatory.	Copernicus, 1; 176 (1881).
38	Observations on the Light of Telescopes used as Night-Glasses.	Am. Jour. Sc., 3 s., 22: 129-131 (Aug., 1881).
39	Observations of Comet *b* 1881 [1881, III], made at the Washburn Observatory. (Illustrated).	Am. Jour. Sc., 3 s., 22: 260-263 (Oct., 1881).
40	Publications of the Washburn Observatory of the University of Wisconsin. Vols. i, ii, iii, iv.	Madison, 1882-'86. 4 vols. 8°.
41	Monograph of the Central Parts of the Nebula of Orion. (Illustrated.)	Washington, 1882. 230 pp. 4°. (Washington Observations, 1878, App. I.)
42	Observations of the Transit of Mercury, 1881, Nov. 7, at Mount Hamilton, California.	Am. Jour. Sc., 3 s., 23: 48 (Jan., 1882).
43	On the Inclination of the Ring of Saturn to its Orbit, deduced from Washington Observations.	Month. Not. Roy. Astron. Soc., 42; 304-307 (April, 1882).
44	Measures of the Rings of Saturn in the Years 1879, 1880, 1881, and 1882.	Am. Jour. Sc., 3 s., 23: 387-394 (May, 1882).
45	Figure of the Nucleus of the Bright Comet of 1882 [1882, II]. (Illustrated.)	Am. Jour. Sc., 3 s., 24: 435 (Dec., 1882).
46	Report of the Eclipse Expedition to Caroline Island, May, 1883.	Mem. Nat. Acad. Sc., 2: 1-146 (1883).
47	Observations of the Transit of Venus, made at the Washburn Observatory.	Am. Jour. Sc., 3 s., 25: 71-74 (Jan., 1883).
48	List of Twenty-three New Double Stars discovered at Caroline Island by E. S. Holden and C. S. Hastings.	Science, 2: 66 (July 20, 1883).
49	Preliminary List of Errata in Yarnall's Catalogue.	Astron. Nachr., 107: 261-268 (Oct., 1883).
50	A System of Local Warnings against Tornadoes.	Science, 2: 521 (Oct. 19, 1883).
51	Proper Motion of Lacaille 8262.	Astron. Nachr., 107: 273 (Oct., 1883).
52	The Narrow Belt on Saturn. (Illustrated.)	Observatory, 7: 74 (Mar., 1884).
53	Statistics of Stellar Distribution derived from Star-Gauges and from the Celestial Charts of Peters, Watson, Chacornac, and Palisa.	Observatory, 7: 249-256 (Sept., 1884).
54	The Lick Observatory.	Sid. Mess., 3: 301-303 (Dec., 1884). *See also* Overland Mon., n. s., 6: 651-655 (Dec., 1885).
55	Sketch of Professor S. P. Langley.	Pop. Sc. Month., 27: 401-409 (July, 1885).

EDITOR'S TABLE.

AN UNHAPPY "SURVIVAL."

CONSIDERING that we are drawing near to the end of the nineteenth century, and that the thought of our day is supposed to be more or less dominated by the scientific spirit, it is extraordinary to find certain words and phrases in common use that imply a survival of modes of thought proper only to periods of barbarism. As an example we would cite the word "luck," and all the familiar phrases in which that word is employed. By common consent, apparently, "luck" is a thing not to be defined; but it is none the less spoken of—and that not only by the ignorant and uneducated—as something exercising a real and potent influence on the affairs of men. It is qualified as good or bad: the man who has good luck enjoys the protection, as it were, of a guardian angel; the man who has bad luck is haunted and pursued by a malignant spirit. It is not men only who can be "lucky" or "unlucky"; ships, houses, railway lines, special days, special numbers, special gems, etc., may likewise fall into either category. It is even fashionable to talk about "mascots"—a mascot being an object, animate or inanimate, that contributes to the good fortune of its possessor. Thus we read a few days ago in one of our daily papers of a dog that was, as the traveling public believed, the "mascot" of a steamboat. The rage for horseshoes, as "lucky" things to nail up on one's premises, is perhaps as great as ever it was. Fashionable society, particularly, seems disposed to fondle the superstitions that science is laboring to banish. The light has come into the world, but there are those who neither comprehend it nor wish to comprehend it. Even on the part of men of scientific mind we find occasionally an unguarded use of language suggesting a participation in beliefs which, if seriously presented, they would strenuously condemn. Thus that excellent writer, Mr. S. Laing, author of one of the most interesting and useful books of the present day, "Modern Science and Modern Thought," says, in the concluding chapter of that work, that, if a laboring-man has once saved ten pounds, he may, "*if he has any luck*, readily make the ten a hundred or even a thousand pounds." Now, we think this an unfortunate expression: the idea it suggests is one which the writer would be the first to repudiate; and yet it might easily be quoted as evidence that even a most enlightened scientific writer recognizes "luck" as an element of success.

There is little use, probably, in arguing with people whose belief in luck is sincere and deep-seated. Such must be left to the education of experience and the influences of the time; and, likely enough, even with these aids, they will not unlearn their errors. But there is another class who, when they use the terms "luck" and "lucky," do so in a careless, indolent manner, or at most with only a half-belief that the words have any real significance. To these it may be well to represent that to talk of "luck" is simply to shuffle out of the responsibility of assigning things to their proper causes; and that, while this careless way of talking may do no special harm to the intelligent man who knows better than to be imposed upon by his own phrases, it does harm to people of less intelligence by confirming them in their delusions. It might perhaps be affirmed, indeed, that no man, however intelligent, can alto-

gether escape harm if he permits himself the habitual use of terms implying degraded forms of belief. There is such a thing as intellectual pitch, which people who want to have their thoughts clean should be careful not to handle.

The career of President Cleveland is often spoken of as a great example of "luck," and this in quarters where one would expect more rational discourse. We imagine that President Cleveland knows pretty well how to account for his so-called luck. He knows that it has been a matter of hard work, of close attention to business, and of presumed identification with a rising popular sentiment in favor of improved political methods. "But," some inveterate believer in luck may urge, "other men have fulfilled all these requirements, and yet have never become Presidents or even Governors. Why should Cleveland, in particular, have been so successful?" We have here a fine example of one of those questions which, as Mr. Spencer says in his chapter on the "Data of Philosophy," imply very much more than the questioner is aware of. It implies that there are some reasons why the particular man who succeeded should *not* have succeeded; for, if there were no reasons to the contrary, what is the sense of asking why a man succeeded who had, admittedly, the qualifications for success? No conceivable action of social and political forces could raise every man, or even every qualified man, in a community to presidential rank; and yet some one man must, at every moment, hold that rank. What need, therefore, to suppose that a mysterious influence called "luck" has anything to do with determining the choice of the community? We see what we may call impersonal forces at work which, from their very nature and the conditions under which they operate, *must* result in the choice of one and the passing over of many others; and yet, when this inevitable result has been arrived at, some people are not satisfied until they have dragged in "luck" to account for it! There are thousands of events that can not be foreseen, the elements on which they depend being too complex for calculation; but none the less are they, and must they be, determined by natural causes. When we cant over a stick of timber, we can predict with certainty how it will fall; partly because the forces brought to bear upon it are of a simple character, and partly because their ratio to the work to be done—to the weight to be moved—is such that a little more or less will not affect the main result. But when we rattle dice in a box, the conditions are reversed: the forces now are many and complex, and are vast in relation to the work to be done. What will be their outcome in the position of the dice on the table, it is altogether beyond human skill to calculate. Were the stick of timber to be hurled from a volcano, carried along by a mighty torrent, or blown up by dynamite, its movements too would become incalculable; but the laws of Nature would not, on that account, lose their hold of it for one moment. Neither do the laws of Nature lose their hold of the dice. There is really no chance in either case; simply an inability on our part to foresee, and therefore to adjust ourselves in advance to, a result which the laws of Nature are working out. If we look closely into the matter, we shall see that all chance occurrences, or what we call such, are simply occurrences lying outside of the range of our calculations, and to which therefore we can only adjust ourselves *after* the event, whereas, in the case of things we foresee, we make, or may make, our adjustments beforehand. As knowledge increases, and methods of observation and reasoning improve, many things pass from the region of the incalculable to that of the calculable, and, to an infinitely enlarged intelligence, all that appears to us now as most completely fortuitous would appear as

the direct and inevitable result of certain interactions of force.

The man who talks of luck, meaning anything by it, simply throws dust in his own eyes, and blinds himself to the natural and ascertainable causes on which many results of more or less importance to himself depend. He blames his luck, when he should blame some specific short-coming in his own conduct. He attributes another man's success to luck when he should attribute it to prudence, ability, or character. There is a vast amount of "luck" in being always ready to take advantage of opportunities. It is a happy thing to have one's lamp trimmed and burning; and a most unhappy thing to have to go off in quest of oil when the hour of the festivity arrives. Some would call the first a case of good luck, and the latter a case of bad luck; but we fail to see why such outlandish terms should be applied to preparedness on the one hand and unpreparedness on the other. As we have already said, we must make allowance in life for the unforeseen and uncontrollable; but the general law holds good that he who wisely calculates what admits of calculation, and wisely controls what admits of being controlled, will place his life and happiness on sound foundations. Such a man will have little reason to complain of luck and little disposition to praise it. We suggested, last month, a theme for teachers in our public schools; we suggest, this month, another—the folly of trusting to luck, and the almost equal folly, on the part of those who do not believe in luck, of talking as if they did.

THE RECENT EARTHQUAKE.

The earthquake of the night of the 31st of August, by which the city of Charleston, South Carolina, suffered severely, was generally felt throughout the States east of the Mississippi River, extending along the Atlantic coast from the Gulf of Mexico to Northern New England, and being perceptibly felt in several towns on the Mississippi. It was more strongly felt in the South than in the North, and the center of most violent manifestation was at Charleston, or near it. In other parts of the country the strength of the shock varied without any obvious rule, spots at a very short distance from one another feeling it in very different degrees. The time of the shock was fixed at about 9·54 Eastern standard time, while the gradual retardation in going west showed that the propagation of the movement was generally in that direction. At Charleston, the earthquake was extraordinarily severe. Many buildings were destroyed, the historic churches of St. Michael and St. Philip were ruined, between fifty and one hundred persons were killed, telegraphic communication was interrupted, and the streets were so filled with rubbish, or so dangerous in consequence of the imminence of tottering walls, that business was suspended for several days. Hardly a house in the city, it was said, escaped injury, and many were so shaken and cracked that a hard blow would bring them to the ground. The shock was equally severe at Summerville, where the whole business part of the town was wrecked, and several lives were lost. At Tybee Island, at the mouth of the Savannah River, the lenses in the lighthouse were broken, and the machinery of the lamps was disarranged, while the water was so agitated that the approach of a tidal wave was for a time apprehended. At Cleveland, Ohio, clocks whose pendulums swung east and west stopped at half-past nine, local time. The most coherent observations of the phenomenon were made at Washington in the Signal-Service Office, and by Mr. McGee, of the Geological Survey, and Professor Simon Newcomb. At the Signal-Service Office four shocks were noticed, of which the first lasted forty seconds and was most severe. The first of the three or four shocks mentioned at Charleston was also the

most severe and was the one that did the principal damage. The second shock lasted four seconds, and the third and fourth shocks were very light. Professor Newcomb observed three shocks, the first of which he fixed at 9·53·20. Mr. McGee, after the culmination of the first shock, timed the phenomena, improvising a seismoscope out of a tumbler of water placed on a stand, and a rude seismometer out of the high head-board of his bedstead. The following is the record of his observations:

"Time of culmination of first shock (seventy-fifth meridian) 9·54½; duration of first shock (estimated), eighty seconds; time of termination of same, 9·55; time of termination of the slight tremor, 10·00 (several slight tremors followed but were not timed); time of recommencement of continuous tremors, 10·08; time of culmination of the second shock, 10·09½; duration of second shock, about thirty seconds; time of termination of second series of tremors, 10·13. The direction of vibration, as indicated by the improvised seismoscope, was a little north of east, but there was an indeterminate vertical component in the undulation plainly perceptible in the motions of liquids and of articles of furniture. Roughly, the upward impulse in each vibration appeared to be one third or one half of the lateral impulse.

"The rate of vibration was measured on the high, swinging head-board of a bedstead during the second shock, and found to be one hundred and fifteen or one hundred and twenty per minute. During the second shock the head-board, eight and a half feet high, swung through an arc of from one half to three quarters of an inch. It was estimated that the amplitude of oscillation during the earlier shock was twice or thrice as great."

Mr. Richard Randolph, civil engineer, of Baltimore, gives the time of the first shock as 9·53½. The oscillations in his room were emphasized by the synchronous beating of some object in his bedroom, which upon examination he found to be the tapping of the door of a wardrobe, and that, he observes, could only be produced with an east-and-west oscillation. To reproduce the tappings with the intensity and period that marked them during the earth-movement required a movement of half an inch at six and a half feet from the floor, for a complete oscillation. At Rochester, New York, a magnetic storm was observed to be raging all the morning of September 1st. It was observed, at the Signal-Service Office in Washington, that the self-registering wind-vane showed a horizontal mark preceding and subsequent to the shaking, denoting a mild, steady breeze, but, for the thirty or forty seconds of most violent shaking, the marks indicated great and rapid agitations of the registering-pencil. Captain Vogel, of the steamer city of Palatka, observed at sea, twelve miles off Port Royal, "a terrible rumbling sensation," which lasted about a minute and a half. There had been a heavy sea from the southeast, but when the rumbling began the wave-motion ceased and the waters remained perfectly quiet until the rumbling stopped, when the wave-motion again became manifest. The depth of the water at Charleston has not been greatly affected; but, according to Captain Bontelle, it has been increased by from six inches to a foot. Fainter shocks have been reported from Charleston as occurring nearly every day since the principal catastrophe.

THE BRITISH AND FRENCH ASSOCIATIONS.

THE meetings of the British and French Associations this year were successful from both scientific and material points of view. The city of Birmingham, where the British Association met, provided so well for the accommodation and entertainment of its guests, that Mr. Galton, in seconding the usual

vote of thanks to the people, said that the meeting would stand prominent in regard to comfort as well as to its scientific qualities. In the latter feature it stood very high. The programme in every section was full to excess, so that, while usually all the sections have finished their work on the Tuesday, and some of them on the Monday, five sections had this year to meet on the Wednesday. In all, three hundred and eighty-eight papers and reports were brought forward, the larger numbers of which were, in mathematics eighty-four, and geology seventy-seven. A new feature, and one the introduction of which was crowned with unexpected success, was that of provision for the discussion in some of the sections of subjects of unusual and pressing importance. The discussions on this plan in the joint meetings of the Physical and Biological Sections on color-vision, and in the Geographical Section on geographical education, were particularly edifying. Another discussion which followed the reading of a paper by Mr. Seebohm, on the theory of physiological selection, recently announced by Dr. Romanes, in which Professors Michael Foster and Newton and Francis Darwin took part, showed that the prevailing sentiment of the section was still in favor of Mr. Darwin's view and against Dr. Romanes's proposed modification of it. Another instructive discussion was on the existence of a pre-glacial man. About the usual proportion of the papers read were of a technical or special character, and a few were perhaps hardly at home in such a body as this; but the very full reports of the meetings in the London "Times," occupying about twenty-five columns, show how much was said and done that was of such living interest and value as to appeal to the general public. The addresses of the sectional presidents, of the essential features of which we give abstracts in another place, were for the most part attractive and intelligible presentations of the particular fields of research in which their authors are engaged. Public interest in the meetings may be gauged by the fact of the sale of twenty-five hundred membership tickets. Appropriations of thirteen hundred pounds sterling were made in encouragement of research in numerous fields. The meeting of the French Association was held at Nancy, under the presidency of M. Friedel, the chemist, and was marked by a numerous attendance and the presentation of a good list of papers, indicating a healthy growth. The secretary reported that three hundred and forty-two contributions had been presented at the Grenoble meeting of last year—being within forty-six of the number offered at the British Association this year. The treasurer presented reports showing that the financial strength of the Association and its consequent power for usefulness were steadily increasing.

LITERARY NOTICES.

ARISTOCRACY IN ENGLAND. By ADAM BADEAU. New York: Harper & Brothers. 1886. Pp. 306. Price, $1.25.

THERE was need of such a volume (especially in this country) as that which General Badeau has here prepared. The truth is, that our national independence and the birth of the Great Republic consisted in little else than a formal repudiation of the British aristocratical system—monarchy and nobility; so that it can hardly be expected that the American people would be very impartial judges of the merits of a system we have got rid of under such circumstances. Our general idea is, that the English aristocracy is a worn-out, worthless, useless, ridiculous, and tyrannical system that is destined to disappear in a very few years. But American contempt for English aristocracy hardly equals American ignorance of it.

General Badeau recognized that there was wanting a book that should give an in-

telligible account of the aristocratic side of English life by explaining the parts and general working of the scheme. He desired to make the American reader understand the facts in such a way as to avoid injurious prejudice and favor an intelligent judgment. His subject is by no means a trivial or frivolous one. Aristocracy is a phase of society in some of its forms universal; and the English aristocracy is the best-preserved and most perfect and powerful in the world.

The author of this volume is a thorough-going democrat in the sense that he is no believer in aristocracy, and condemns it of course unsparingly; but he is unbiased enough to give a trustworthy account of its mechanism and workings. For this he seems to have very well prepared himself. Besides wide reading and special study of its various elements, he has had a dozen years' direct observation and experience of it in the diplomatic service.

It is the care with which he has availed himself of these opportunities that gives, perhaps, the most attractive feature to his book; he is full of anecdotes, incidents, brief personal sketches, and vivid delincations of the working of the various social parts in the aristocratic life. General Badeau has not attempted a philosophical book. While his volume is full of instructive lessons, he runs into no deep disquisition, and has struck the happy medium that will make it entertaining to all readers. The subject is not only a fascinating one, but a most important one, and, if we may venture to say so, a good deal more important than would appear from General Badeau's treatment of it. The author confines himself, in accordance with his plan, to descriptive details of the social operations that English aristocracy involves, and this probably prevented him from dealing with some of the remoter influences of the aristocratic policy. But the problem of the influence of aristocratical organizations in England on the whole subject of education for several centuries, and at the present time, is one of the most pregnant that the student of modern mental development has to deal with. General Badeau's book is an excellent introduction to this subject, but the author does not enter upon it.

THE JUGURTHINE WAR OF C. SALLUSTIUS CRISPUS. Edited, etc., by CHARLES GEORGE HERBERMANN. New York: D. Appleton & Co. Pp. 272. Price, $1.12.

THE editor has aimed, in preparing this volume, to assist the student, as far as possible, with all the resources of modern scholarship; and, in compiling the notes, he has endeavored to omit nothing in the way of historical illustration that can aid the learner to obtain a fuller and clearer insight into the meaning and spirit of the author. The text of Jordan, which is in the best repute in German and English schools, has been adopted, while archaisms and variations in spelling are avoided, as only likely to perplex students. Besides the notes, an introduction giving the life of Sallust, observations on his style and syntax, and historical information respecting the kingdom of Numidia and the Jugurthine war, has been added; and a convenient vocabulary saves the necessity of encumbering one's self with a separate dictionary.

A HISTORY OF EDUCATION. By F. V. N. PAINTER. New York: D. Appleton & Co. Pp. 335. Price, $1.50.

THIS is the second volume of the "International Education Series," which D. Appleton & Co. have projected, to be prepared under the editorial supervision of W. T. Harris, to provide works of a useful and practical character for the libraries of teachers and school managers, and text-books in normal classes. The author is Professor of Modern Languages and Literature in Roanoke College, Virginia; and the preparation of this history was suggested by him while examining the German works on the subject in the library of the University of Bonn, in view of the poverty of our literature in educational history. In it he views the history of education from the point of the philosophy of history, or history of civilization, and traces it in its relations with the social, political, and religious conditions of each country. The system of education in each nation is regarded as conformed to its religion, art, social customs, and form of government, but most of all, generally, to its religion. Hence, a new phase of civilization, giving new ideals in these domains, demands a new system of education. The systems that have prevailed from the remotest

past down to the present time have been modified by all the changing conditions of national life to which they have been conformed, and have been molded in sympathy with the ideas which were dominant in the races among which they have been applied. Following the subject in its chronological and logical relations, attention is first called to the Oriental countries, in which are included China, India, Persia, Palestine, and Egypt. In these lands, the individual counts for nothing; and education does not aim to develop a perfect man or woman, but to prepare its subjects for their place in the established order of things. Subjection to authority is the principle on which most stress is laid, while the source of the all-controlling authority may vary in the different countries. Quite different were the ideas in the classical nations, Greece and Rome, where the individual was brought into prominence: education was made the subject of careful thought and was controlled by higher principles; enlarged views of its nature were promulgated; and beautiful results were obtained as exhibited in the physical and intellectual life of the people. With the Christian dispensation came a new era in history, and education was profoundly affected and placed on a new and immovable foundation. The history of Christian education in Europe and America is naturally divided into two periods—the period before the Reformation and the period after the Reformation. The story of the latter period is largely occupied with the struggle between the "humanist" and the "naturalist" or modern tendencies, which has continued and is still going on in our own day. Finally, under the heading of "Education in the Nineteenth Century" are reviewed the systems of Pestalozzi and Froebel, and contemporary education in Germany, France, England, and the United States.

THE DEPRESSION IN TRADE AND THE WAGES OF LABOR. By URIEL H. CROCKER. Boston: W. B. Clarke & Carruth. Pp. 31.

MR. CROCKER is the author of the pamphlet entitled "Excessive Saving a Cause of Commercial Distress," which was noticed in the "Monthly" several months ago. In the present pamphlet he continues the discussion of the subject, and endeavors to give his views a practical direction. Reviewing the various theories that have been advanced to account for the present supposed hard times—when the "suffering" working-men are rejoicing to put themselves in idleness—he plants himself upon that which ascribes the depression to over-production. "We have," he says, "increased production by bending all our energies in that direction, aided all the while by the immense increase in the effective power of the machinery of production and distribution, and by the fact that years of labor spent in the creation of that machinery have brought us to a time when we are prepared fully to enjoy its use. On the other hand, we have done comparatively little for the increase of consumption. The possibility of such increase by the poor has been enlarged but little, while the inclination of the rich therefor has been greatly restricted. Under such circumstances, what wonder that production has run ahead of consumption—what wonder that general over-production, as an actual existing fact, has finally been reached?" His views of the means of remedying the conditions he depicts are quite as indefinite as those of most of the writers who have given attention to the subject. After dismissing several suggestions as remedies to be avoided rather than sought for, he falls back upon strikes and boycotts, but can not conceal an apprehension that they too—as they have done—will prove to have the action of a boomerang.

ASTRONOMY BY OBSERVATION. By ELIZA A. BOWEN. New York: D. Appleton & Co. Pp. 90. Price, $1.

BY observation mankind learned all the astronomy it knows, and came to the theories it holds as correct. By observation, Miss Bowen believes, pupils in schools can to-day be best taught to learn the phenomena of the heavenly bodies, and be guided to the deduction of the principles on which they depend. A brief article on "Astronomy in High Schools," which the author published in the "Monthly" of January, 1882, describing her experiences with her pupils in the method of observation, will furnish the key to this book, which has grown out of these experiments. "My ob-

ject," she then says, "has been to gain for my pupils from this study, not merely knowledge, but all the mental discipline it could afford. In order to accomplish this, I have made it an invariable principle to make them do all the observing, all the thinking, possible. They have watched the heavenly bodies to discover their appearance and motions, and then I led them on to discuss the causes. It has been genuine inductive study, so far as it has gone. My own work seemed very simple; but it occasioned me a great deal of observation, thought, and study. I have simply kept them on the track." This book is intended to aid other teachers in the performance of that duty, and to help the pupil too. In it, an efficient, easy, well-tried plan for teaching the constellations is described, the use of which will obviate the necessity of a teacher doing work out of school-hours, by enabling students to become independent observers; careful directions are given when, how, and where to find the heavenly bodies; and their motions are described in the order in which they can be seen by an observer, and in familiar language. Thus the student is excited to thought. He is prompted to see for himself, and then can not avoid the inquiry what it all means. In order that his inquiries may take the right direction, facts are in the book stated first, and theory is given afterward, as a deduction from the facts. The selection of subjects for the student's thinking is a little different from that of other school astronomies. The general principle governing it is to make the student understand what he can see. Miss Bowen has also sought to make her book of use to those instructors who have little or no practical knowledge of the science, but who would improve if the text-book were a guide to observation, and to the increasing class of young people out of school who would study the stars for themselves if they had suitable leading.

A FARMER'S VIEW OF A PROTECTIVE TARIFF. By ISAAC W. GRISCOM. Woodbury, N. J.: Published by the author. Pp. 53.

IT would be hard to find in the literature of political economy an author who has written about the protective tariff with a clearer head than this "farmer." The basis of his thesis is that, agriculture having been recognized on all sides as by far the most important business interest in the nation, it has followed that one of the main arguments in favor of maintaining a protective tariff has been, that it would aid agriculture by creating increased home consumption with steady and remunerative prices for the farmer's products. "This looks very well, to be sure, as a theory, but, after twenty years' experience, the agriculturist finds himself getting no more (a good deal less, in fact) for his products than before the civil war; and, with his necessary expenses very much greater than then, he naturally begins to wonder if there was not something wrong in the original calculation." Mr. Griscom then proceeds to show that there was something wrong there, and wherein it lay.

THE REAR-GUARD OF THE REVOLUTION. By EDMUND KIRKE. New York: D. Appleton & Co. Pp. 317. Price, $1.50.

THIS work presents a chapter in American history of which not so much is known as ought to be, but which, if the view the author takes of it is correct, is of exceeding importance. It embodies the history of three of the pioneers of the central region of the United States, who, "clad in buckskin hunting-shirts and leading inconsiderable forces to battle in the depths of a far-away forest, not only planted civilization beyond the Alleghanies, but exerted a most important influence in shaping the destinies of this country." They were John Sevier, Isaac Shelby, and James Robertson, "all of them characters worthy of the most heroic ages, and so exactly adapted to the work which had to be done that the conclusion is irresistible that they were, like Lincoln and Washington, 'providential men.' . . . Their slender forces trod silently the Western solitudes, and their greatest battles were insignificant skirmishes, never reported beyond the mountains; but their deeds were pregnant with consequences that will be felt along the coming centuries." These ascriptions are justified, in the author's mind, by the conclusion at which he has arrived from his studies, that two of the men thrice saved the country by thwarting the British plan to envelop and crush the Southern colonies, and by turning the

tide of the Revolution at King's Mountain; and that after the Revolution the three, acting together, frustrated the design of Spain to dismember and weaken the Union by causing the erection of a separate republic in the country between the Alleghanies and the Mississippi. The materials for the history were gathered principally from old settlers of East Tennessee and Western North Carolina. The present volume does not tell the whole of the story, but is to be supplemented by a second, in which events will be brought down to the deaths of Sevier and Robertson.

INSECTS AFFECTING THE ORANGE. By H. G. HUBBARD. Washington: Government Printing-Office. Pp. 220, with Plates.

MR. HUBBARD was employed as a special agent of the Entomological Division of the Agricultural Bureau, in Florida, and devoted his time for nearly four years in studying the insects that affect the orange, and in practical experiments to counteract their injuries. "It is but uttering a deserved compliment," Dr. Riley remarks, "to say that the practical results of his labors have been most satisfactory, and mark an important era in the history of orange-growing in the United States." The trees of the citrus family are particularly subject to the disastrous ravages of various species of scale insects, which not infrequently thwart all effort to raise a grove. It is to these that the present report is chiefly devoted, and to their control that the greatest efforts were made. The practical object—that of helping the orange-grower in the warfare which must be waged with insect foes—has been held foremost in the preparation of the report; but scientific information and more complete descriptions are given, or referred to, for those who want fuller or technical information.

OTTAWA FIELD NATURALISTS' CLUB. Transactions No. 6. Ottawa, Canada. Pp. 130, with Plates.

THE club is now incorporated, and returned, for 1884–'85, 168 members. Of the year's collections, mention is made of 920 plants, 208 species of shells, 198 of birds, 48 of fishes, and 1,004 of insects. It is suggested in one of the special reports, recommending the local study of natural history, that "were local societies, instead of wandering aimlessly among the paths of natural science, to devote themselves to this work, . . . there would soon be accumulated a fund of information more perfect and complete than by any other method. The inaugural address of President H. Beaumont Small points out to the members the fields of investigation which they may find in the several orders of the animal kingdom. It is followed by papers on "The Canadian Otter," by Mr. W. P. Lett; "The Minerals of the Ottawa District," by Mr. C. W. Willimott; "Terrestrial Mollusca of Ottawa," by Mr. F. R. Latchford; "Wheat, with Especial Reference to that grown in the Ottawa District," by Mr. William Scott; "Our Saw-Flies and Horn-Tails," by Mr. W. H. Harrington; "Our Trenton Fossils," by Mr. W. R. Billings; "The Geology and Paleontology of Ottawa," by Mr. H. M. Ami; Reports of the Paleontological, Botanical, Conchological, Entomological, Ornithological, and Zoölogical Branches; and an Abstract of Meteorological Statistics, by Mr. A. McGill.

ARCHIVOS DO MUSEU NACIONAL DO RIO DE JANEIRO (Archives of the National Museum of Rio de Janeiro). Vol. VI. Rio de Janeiro. Pp. 560, with numerous Plates. CONFÉRENCE FAITE AU MUSÉUM NATIONAL, EN PRÉSENCE DE LL. MM. IMPÉRIALES (Lecture delivered at the National Museum, in the Presence of their Imperial Majesties). By Dr. LADISLÁU NETTO. Rio de Janeiro. Pp. 28.

THE volume of the "Archivos" relates to the ethnology, anthropology, and archæology of Brazil. Among the papers it contains are "Contributions to the Ethnology of the Valley of the Amazons," by C. F. Hartt; "The Man of Sambaquis, a Contribution to the Anthropology of Brazil," by Dr. J. B. de Lacerda; "New Craneometrical Studies on the Botocudos," by Dr. J. R. Peixotto; and "Investigations upon Brazilian Archæology," by Dr. Ladisláu Netto. These papers are richly illustrated with colored and monochrome plates, and engravings inserted in the text. Of particular interest is a series of plates of comparative symbolical characters, which show the similarity of the symbols for corresponding objects in the Márajo (of Brazil), Mexican, Chinese, Egyptian, and Indian

writings. The lecture of Dr. Netto, who is Director-General of the National Museum, presents a summary in the French language of the results of archæology in Brazil, and is devoted largely to the explanation of the principal features of the papers contained in the "Archivos."

LORENZ ALMA-TADEMA: HIS LIFE AND WORKS. By GEORG EBERS. New York: William S. Gottsberger. Pp. 94, with Thirteen Plates.

ALMA-TADEMA—a Frisian by birth—is one of the foremost of English painters, and an artist whose style—except as he may have had imitators—is unique. His favorite themes are the severe classical and mediæval. Dr. Ebers is his close friend, and has undertaken to present this review of his life and works under the impulse of the thought that "he who knew him so well as a man also understood him as an artist, and would probably be able to give a faithful picture of his life." The illustrations are representations of some of the artist's most famous works.

LETTRE À MONSIEUR ERNEST RENAN À PROPOS DE L'INSCRIPTION PHÉNICIENNE APOCRYPHE (Letter to M. Ernest Renan respecting the Apocryphal Phœnician Inscription). By Dr. LADISLÀU NETTO. Rio de Janeiro. Pp. 35, with Plates.

IN 1872 Dr. Netto submitted to the Historical, Geographical, and Ethnographical Institute of Brazil a pretended Phœnician inscription which was said, by one Joaquin Alves da Costa, to have been found by his slaves on one of his estates. It was afterward ascertained, and Dr. Netto was convinced of the fact, that the inscription was false. In this letter, addressed to M. Renan as "one of the most illustrious Orientalists of modern times," the author explains his relations to the matter, for which he has been subjected to unfavorable criticism, but which appear to have been entirely honest.

KIDNAPPED. By ROBERT LOUIS STEVENSON. New York: Charles Scribner's Sons. Pp. 324. Price, $1.

THIS story—of the Highlands and the Highland life of Scotland at a period when the land was tormented by contentions—sets forth the adventures of David Balfour in the year 1751; "how he was kidnapped and cast away; his sufferings in a desert isle; his journey in the wild Highlands; his acquaintance with Alan Breck Stewart and other notorious Highland Jacobites; with all that he suffered at the hands of his uncle." The author is known as a story-teller of vigor and dramatic force, and as vivid in description; and the picture on the cover, of a Highlander jumping over a waterfall, promises exciting times to the reader.

FOURTH REPORT OF THE UNITED STATES ENTOMOLOGICAL COMMISSION. By CHARLES V. RILEY. Washington: Government Printing-Office. Pp. 147, with Maps and Plates.

THIS report relates to the cotton-worm, concerning which it embodies the final report, with a chapter on the boll-worm. The investigation of the cotton-worm was begun in 1878, and continued during four years; and the results of it, according to the showing here given, have been fruitful. The history of the subject and the various matters relating to the worm, its depredations, and the treatment of the pest, are gone into with considerable elaboration. In the successive chapters of the report are considered the natural history of the insect; its past marked appearances and the remedies proposed, chronologically arranged; the distribution and anatomy of the *Aletia;* the cotton belt, its characteristics and peculiarities; the influence of soil, weather, etc., upon the first appearance of the worms and their increase and destructiveness; the natural enemies of the insect; means of destroying the worm; machinery and mechanical devices adapted to that purpose; the literature of the subject; insects liable to be confounded with the true cotton-worm; and the boll-worm.

THE MYSTERY OF PAIN. By JAMES HINTON, M. D. Boston: Cupples, Upham, & Co. Pp. 120.

FROM the introduction to this book by Dr. J. R. Nichols, we learn that its author was for many years a sufferer from despondency, and a victim to much mental and physical pain, and was also a deeply religious man. He himself employs, to illustrate the reason of pain, the supposition of an island, the climate of which is so

unhealthy that the inhabitants are constant sufferers from rheumatism, so that walking would be painful to them. They would call walking an evil. "But in this their thought would be false. They would be feeling a good thing painful because they did not understand their own condition. And if it could be explained to them that the cause of their pain was not anything bad in walking, but only their own disease, that itself would be a gain to them. . . . Now, this is the idea I have tried to explain in this little book; namely, that things which we have inevitably called evil may yet be truly good. My thought was that all which we feel as painful is really giving something that our fellows are better for, even though we can not trace it; and that giving is not an evil thing, but good, a natural delight and good of man; and that we feel it painful because our life is marred." To quote from Dr. Nichols again, the cure for pain which Dr. Hinton suggests "rests on a religious basis; and hence has no meaning or significance to those destitute of religious faith."

OBSERVATIONS ON VOLCANIC ERUPTIONS AND EARTHQUAKES IN ICELAND WITHIN HISTORIC TIMES. Translated and condensed by GEORGE H. BOEHMER. Washington: Government Printing-Office. Pp. 46.

THIS paper has been prepared in connection with the Smithsonian Report for 1885, and is abridged from a larger paper by Th. Thoroddsen. Although the volcanoes and hot springs of Iceland are treated of in a work written at about the middle of the thirteenth century, in which some superstitious ideas are advanced as to their origin, and an eruption is recorded in the present paper which took place about A. D. 900, the geology of Iceland was not thoroughly studied till the beginning of this century, and is still little known. The active volcanoes of Iceland are described as in eight groups of from one to five volcanoes each. Within historic times, eruptions have occurred at about twenty different places. Among the large volcanoes, Hecla occupies the first place, with twenty-one eruptions; while others follow, with twelve or thirteen, ten, six, and one each. The largest numbers of eruptions took place in the fourteenth century (thirteen), and in the eighteenth century (fourteen). The earthquakes have been in direct connection with the eruptions. A copious bibliography is appended to the paper.

CASSELL'S NATIONAL LIBRARY. Edited by Professor HENRY MORLEY. New York: Cassell & Co. Thirty-five weekly volumes to date, averaging 192 pages each. Price, 10 cents each.

THIS library gives more for the money —meaning by more, actual value rather than quantity—than any other popular series that is published. It gives in clear, open type, suitable to all eyes that can read at all, and in a shape convenient for the pocket, selections from the best literature of all ages, and particularly from English literature, in works that are complete in themselves. The books have all been named in our monthly acknowledgments of "Publications received," and it is hardly necessary to say more of them particularly than to refer to the titles and authors as there given. In the list are represented by their best works such writers as Silvio Pellico, Lord Byron, Benjamin Franklin, Izaak Walton, Plutarch, Herodotus, Lord Bacon, Horace Walpole, Dean Swift, Sir Walter Scott, Sheridan, Goldsmith, Sir John de Manndeville, Shakespeare, and other authors whose names are fixed in the world's literature, but whose works are not easily got in as accessible form as that in which they are here presented.

HISTORICAL SOCIETY OF SOUTHERN CALIFORNIA. Los Angeles, January, 1886. Pp. 43.

WE do not find anywhere in this report a line from which we may form a conception of the age of the society. Lists of officers for 1885 and 1886 are given, from which we are assured that it is at least about two years old; but it would be interesting to know more exactly how long it has been at work encouraging the study of the history of that district of romantic story in which its peculiar field lies. The address of the retiring president informs us that it enjoys a credit balance which it is hoped may be the beginning of a building fund, and that its monthly meetings are regularly held and attended with lively and interest-

ing discussions. The retiring president, Mr. John Mansfield, recommended a division of the society into sections, embracing various branches of scientific research and history proper, and the admission of the teachers and pupils of the Normal and High Schools to its privileges. These recommendations are approved and made more definite by the new president, Mr. Isaac Kinley, who would also embrace art within the scope of the society's objects. Mr. Kinley urges energetic industry in the pursuit of the special historical work, while those who were not only the spectators but the makers of the history are still among them, and because the records are in a perishing condition. "The old Mission buildings are crumbling into soil, valuable old manuscripts are being gnawed into illegibility by the tooth of time." Besides the two presidents' addresses, the report contains papers on "California in the Eighteenth Century," as it was described by Father Francis Palon, founder of the Mission Dolores, by J. Adam; "The Glacial Period," by Professor Ira Moore; "Trap-door Spiders," by Miss Monks; and "North American Lakes," by Isaac Kinley.

A STUDY OF PRIMITIVE CHRISTIANITY. By LEWIS G. JANES. Boston, 1886. Pp. 319. Price, $1.50.

THIS book is the fruit of many years of study, issuing in a series of lectures for the benefit of "The Association for Moral and Spiritual Education" connected with the Second Unitarian Church in the city of Brooklyn. The point of view is Unitarian as regards theological conceptions of the personality and mission of the Nazarene; but the author is a sincere lover of the character of Jesus, and disposed to do full justice to the influence and value of his teachings. Dr. Janes is evidently a thorough scholar, and one can not fail to be impressed with the care, the honesty, the faithfulness, the impartiality, the love of truth, the conservatism exhibited throughout this admirable volume. Quite irrespective of the author's conclusions upon special disputed points, no one can gainsay that his work is, in the language of the pastor of his church, who writes a preface, "a wonderfully clear and strong expression" of the facts which his study has determined; and that to this study he has brought "a singularly just and patient mind." We commend the book, not only to Unitarians, but to all who are willing to trace, or to see traced in a masterly manner the operation of natural causes, of race, politics, and social conditions generally, upon the rise and progress of Christianity.

It is not within our province to enter upon a critical discussion of either the theological or historical questions which this work involves; but it is very interesting to note the method which Dr. Janes pursues, and observe his theory of the development of the organized Christian system. He follows its course up to the point when it became the Roman state religion, and his conclusions are, that it "arose by a natural process of evolution out of pre-existing systems to complete the overthrow of the prevailing though effete polytheistic *cultus*, and to supplement the narrowness and partialism of the decaying ethnic religions by the principles of universalism and human brotherhood." The influences determining its various phases from the simple altruistic teaching of Jesus to the formidable political power which it came to wield in its union with the state are thoroughly studied and set forth effectively in the method of truly scientific exposition.

The author distinguishes sharply between the Jesus of the first three gospels, the "Triple Tradition," and the Jesus of the fourth. The "Triple Tradition," in his judgment, represents the man as he really was in life, "a simple, noble, manly personage, full of intense conviction and prophetic enthusiasm, who moves naturally and freely in his Hebrew environment." The fourth Gospel, however, presents the Great Exemplar with the incumbrances of the many myths of Aryan and Egyptian thought; and to separate the Christ of actual history from the legendary Christ, to whom have been attached these ancient myths of the East and of Egypt, is one of the main purposes of Dr. Janes's critical study. For instance, the great solar myth is indicated as the source of the narrated miracles of cure, of the doctrine of the Logos, and again of the final miracle of the resurrection.

The religion of the future, Dr. Janes believes to be, "the true religion of humanity,"

which was the simple, unalloyed teaching of Jesus of Nazareth—a very different thing from the Christianity triumphant which was exemplified in imperial Rome—"a compromise with pagan power and sacerdotalism, a hybrid product which the Nazarene would never have recognized as the child of his simple enthusiasm for righteousness, his devotion and self-abnegation, his suffering and agony, his poverty and supreme sacrifice." This religion of the "brotherhood of man," and with it the trustful acceptance of the beneficence of the order of Nature, is the rational fulfillment of Jesus's doctrine of the "fatherhood of God."

FIRST LESSONS IN ZOÖLOGY. By A. S. PACKARD. New York: Henry Holt & Co. Pp. 290. Price, $1.

IN preparing this manual, the author has had in view the excellent plan, which has been adopted in some museums, of placing near the entrance "Epitome Collections," or a series of examples of the principal classes of the animal kingdom, so that the visitor may go into the main collection prepared with an idea of its logical arrangement. The book differs from the author's two other text-books in zoölogy in that it treats of still fewer examples or types; that fewer technical terms and names are used; that it seeks to lead the student from the facts to the principles, without tiring him with formal general statements; and that the subject as a whole is given in somewhat smaller compass—all being in the direction of better adaptation to elementary instruction. The importance of studying from specimens, fresh and alive, using the book as an aid to that study, and not relying upon it alone, is insisted upon; and the pupil is exhorted to go out, look at the animals where they live, and learn how they live.

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POPULAR MISCELLANY.

Low Water in Wells and Typhoid Fever.—Dr. Henry B. Baker, of Lansing, Michigan, supposes a close relation to exist between typhoid fever and low water in wells. The diagrams which he presents in his paper of the prevalence of sickness from typhoid fever in Michigan, and the depth of the earth above the ground-water in the wells during six successive years, seem to show that, beginning with June in each year, the sickness-curve follows more or less closely the well-water-curve. The author believes that one of the causes, probably the principal cause of sickness, is the contamination of the water by the drainage from stable-yards, privy-vaults, and cess-pools, which reaches the wells more directly when the water in them is low, and forms in them stronger solutions than when it is high. On the other hand, the curves in several years, from January to June, show no such correspondence. The difference in results is explained by the frozen condition of the ground in the winters when typhoid did not prevail; a condition which, while it tended to reduce the quantity of water in the wells, at the same time prevented percolation from the surface sources of contamination. The fever was more prevalent in the open winters when percolation was not thus impeded. Corroboration is given to these views by a remark made by Dr. Foster Pratt, of Kalamazoo, at the meeting of the American Medical Association in June, 1874, that typhoid fever was unusually prevalent in Kalamazoo in a certain year in the autumn, at about the time the water in the wells was very low, and some wells became dry.

Professorships of Physical Geography.—Professor H. N. Mozeley, in an address at the Royal Geographical Society's recent exhibition of geographical appliances, made a plea for the establishment in the English universities of chairs for teaching physical geography apart from geology. He quoted from letters which he had received from German professors who are teaching under a plan similar to the one which he proposes. Among them is Professor Kirchhoff, of Halle, who said: "It is, no doubt, correct that geology, in just the same way as geography, is concerned with the earth and all its various parts. But the point of view on either side is different. For example, while I am delivering in Halle during four successive semesters the course on geography, Professor von Fritsch and two colleagues are lecturing to almost entirely different audiences on mineralogy, crystallography, geology, and paleontology. In summer, Professor von Fritsch arranges excursions for geological purposes, and many of the students take part in these, because a problem of great geographical importance is able to be solved during these excursions, namely, the explanation of the form of the land-surface as resulting from its composition, and by means of the history of its development. The two sciences do, indeed, touch one another in what is termed superficial geology, but from this zone of contact they stretch wide apart from one another. Geology discusses not only the developmental history of the earth in the Quaternary period, a matter which concerns the geographer quite as much as the geologist, but it discusses also that of the most remote periods of the earth's antiquity, investigates the petrographic structure and the organic life of every formation, subjects which hardly concern the geographer at all. On the other hand, geography has to deal not only with the land-surface and the waters, but also with climate, the flora and fauna, and human inhabitants, both of the earth as a whole and of each separate country, confining its view to the present only—that is to say, to the Quaternary period. It might as well be said that the existence of history as a subject at universities rendered geography unnecessary, because it also has to do with the entire earth's surface."

Arsenic in Wall-Papers.—Professor H. Carmichael presented some important facts to the American Association in his paper on "The Quantity of Arsenic contained in Wall-Papers." Scientifically speaking, he said, probably no paper in the market is strictly free from arsenic, for faint indications of it may always be discovered when specially delicate tests are applied. For the present purpose, papers containing less than one fiftieth of a grain of white arsenic to the yard are said to be free. Thirty-one samples of paper, which were regarded as average ones, yielded on analysis an average of 2·2 grains to the square yard. It was impossible to classify the papers so that their prevailing colors would bear any simple relation to the amount of arsenic discovered. A paper with green ground, in which arsenic might have been suspected, was the only one in the lot entirely free therefrom, while a paper nearly white contained a quarter of a grain. Papers "warranted strictly free from arsenic" by the manufacturers also contained notable quantities. In general, arsenic is more abundant in the figure than in the ground, and in brilliant than in the light, monotoned papers just now in fashion. Carmine red is particularly distinguished by the amount of arsenic which it usually yields. This is to be attributed to the arsenic employed in the manufacture of aniline red, the common red coloring-matter of paper, and from which, in its manufacture, the aniline fragment is imperfectly freed. This same red dye, with its arsenical impurity, is unfortunately largely employed, on account of its resemblance to the more costly cochineal, in coloring worsted and woolen underwear. It may be easily distinguished from the latter by the readiness with which it imparts its color to wash-water or the skin with which it comes in contact. Unfortunately, there is no guide in the selection of papers free from arsenic except chemical analysis, and no security to the purchaser unless by a prohibitory law duly enforced.

The French Association.—The French Association for the Advancement of Science met in its fifteenth annual session at Nancy, August 12th, and was opened with an address by the president for the year, M. Friedel, the chemist, whose subject was "The Progress of Chemistry and Mineralogy." M. Friedel preceded his address with the announcement that the negotiations for a union with the *Association Scientifique*, had been brought to a happy conclusion, and only a single detail of formality had to be gone through to make the union an accomplished fact. The object of the Association was defined to be, to attract the largest number possible of their fellow-citizens to high scientific culture; not to vulgarize science, or bring it down by taking its true character away from it; but to unite those who cultivate the highest science, and group around them those persons who, without ascending to the summits, wish, at least, from medial regions, to follow with their eyes the traveler going up, through the obstacles, from peak to peak, without ever reaching the last one. In his conclusion, he recommended as another purpose, which they could all seek without provoking jealousies, the advancement of the intellectual and moral glory of their country. "Science," he said, "is a marvelous agent of industrial progress, and those labor under a false inspiration who regard it as a superfluity of an aristocratic civilization. Economic failures must soon remind them that the industry of routine has now lived its day, and that that only is vital which rests closely on the knowledge of the laws of matter. Science is no less favorable to moral development. How the assiduous search for truth, whether in the world of matter or in that of extent and quantity, elevates the mind and fortifies the heart! How much ought the comparison of the little that we know with the infinitude that we do not know to contribute to make us modest!" Another advantage of helping the progress of science is that, while we differ on so many other questions, we can be one in that. M. Colligon, the secretary-general, made the annual report of the history of the Association during the year. An address of welcome was made by the Mayor of Nancy, who said that they desired to create there a great center of French science, to compensate for what they had lost at Strasburg. An important discussion took place, in the Agricultural Section, on wheat-production, in which the competition of India was acknowledged to be formidable, and threatening to become

more so. M. Cartaillac, in a paper in the Anthropological Section, on primitive burial rites, maintained that the custom of letting corpses entirely decompose before giving them a definitive burial had been a very prevalent one. Of the excursions, one contemplated to Mount Douon, which is in German territory, was prevented by the jealousy of the German officers, who were not acquainted with the nature of the Association, and feared it might be a political body. The meeting of the Association for 1887 is appointed to be in Toulouse, and that for 1888 in Oran, Algeria.

Regimen for Inebriates.—Dr. Joseph Parrish, in his address as president, at its last meeting, of the American Association for the Cure of Inebriates, analyzed the English system for the care of persons of this class as exemplified in the "Habitual Drunkards Act," and described the five retreats that have been licensed under the act, together with several retreats under the voluntary system which have not taken out licenses. The licensed retreats are: Dalrymple House, Rickmansworth; Tower House, Westgate-on-the-Sea; Old Park Hall, Wallsall, Staffordshire; High-shot House, Twickenham; and Colman Hill House, Halesowen, Worcestershire. These institutions gave good accounts of their operations, but seemed to regard themselves, generally, as still in the experimental stage. The reports from the voluntary retreats are more varied, and some of them furnish suggestions. The "sister in charge" of one house, a woman's home of the Church of England, believes that "one year is necessary for a cure. To tide over the broken-down condition, and remove physical disability, requires at least six months, and the last six months are needed to restore and establish the moral and religious character." Dr. James Greenwood, whose institution is of twenty-five years' standing, says, as a result of his experience, that "bad cases of confirmed inebriety can only be cured by compelling total abstinence for a period of not less than twelve months." He has been tolerably successful, though some cases have taken two years to cure; "but from six to twelve months is usually sufficient." He can more readily obtain patients and induce them to place themselves under treatment by considering them merely as visitors come to reside with him for a time as a private medical man. Dr. James Stewart, late surgeon in her Majesty's navy, says: "Having attendants is a choice of evils; I do not have them. To place a man of intelligence and culture in the care of an ignorant and possibly a rude hireling, is therapeutically wrong. All sources of irritation should be avoided. . . . I consider the first three months of a patient's residence should be given to physical renovation. The second three months should be employed in learning to enjoy life without the usual accompaniment of alcoholic stimulants. . . . The third three months, they should learn to do just as sober and upright people do—to live like other people—and, the longer they continue to accommodate themselves to the new life, the better for them and for all concerned. . . . Rest, abstinence, and tonics, establish a cure." Two rules, recognized as cardinal by all the retreats and homes but one, are—that no intoxicating drink shall be introduced on the premises under any circumstances, unless ordered as a medicine by the medical superintendent; and that no drug of any kind shall be taken by the patients except with the consent of the physicians.

How Water becomes Oxygenized.—In a paper on "The Relations of Air and Water," which he read before the American Association, Professor W. H. Pitt observed that "water falling through air, as, for instance, a small stream poured from a pitcher into a basin of water, will carry down air with it beneath the surface. The air is carried down by adhering to and mechanically mixing with the falling water. Now, as oxygen has greater adhesive property for water than nitrogen, the proportion of these two gases carried along by water in its fall is undoubtedly different from that which exists in the common atmosphere. Water, then, has a selective affinity for oxygen and very little comparatively for the inert nitrogen of our atmosphere. An application of this principle on a magnificent scale may be seen in the great storms of water falling from the clouds to the earth. We may then expect, for a short time at least, and in appreciable

quantities, after a rain, a richer condition of the air in oxygen, which of course would have a corresponding effect upon all substances, organic or inorganic, susceptible of oxidation. It is probable, also, according to this theory, that the outward and upward rush of air at Niagara Falls, with the seething foam, is more than normally rich in oxygen.

Surface-Currents of the Ocean.—Some experiments have recently been made by Professor G. Pouchet, under the patronage of the Prince of Monaco, with relation to the superficial currents of the ocean. The purpose was to determine the existence of a current that might carry warm weather to the coast of Europe. Ten copper spheres, a foot in diameter, twenty kegs, like beer-kegs, and a hundred and fifty well-corked bottles, all bearing requests in several languages, to be taken care of by the finder, were carried to the Azores, and dropped on the 27th and 28th of July, 1885, on a line about one hundred and seventy miles long and running 14° north by east. It was supposed that, if any of the floats reached the coast of Europe, it would be at between 40° and 50° north latitude; but none of them have yet been seen in those regions. Three of the floats were taken up after a travel toward the east, in which they had at the same time inclined toward the south. Two bottles and one keg were found at the Azores; the bottles in positions which showed that they had taken fifty-three days to travel a distance of four hundred and twenty miles, and the keg where it seemed to show that the floats were continuing their course toward the south. The positive though partial results thus obtained appear to establish the fact that, from the latitude in which the floats were thrown overboard, not a drop of the surface-water of the Atlantic reaches the coast of France.

Milk for Infants.—Dr. T. Lauder Brunton has some important remarks, in his paper on "Poisons formed from Food," on the quality of the milk that is given to infants, and the dangers arising from carelessness in using it. Milk, he says, "may apparently be quite sweet at the time it is given, and yet it may really be 'on the turn,' as the term is. When swallowed by the infant, it may rapidly become sour and disagree, while a portion of the same milk, especially if kept cool, may appear to continue sweet for some hours afterward. It is highly probable that not the least advantage possessed by milk drawn from the breast, over that given by a bottle, is that the former is free from bacteria with which the latter is apt to be contaminated. Both may appear equally sweet when administered to the child, but the organisms present in the baby's bottle will continue their action after the milk has been taken, and render it liable to produce vomiting and purging, which are symptoms of poisoning by putrefactive alkaloids. The risk of contamination is much greater when a bottle with a long tube is used, for the bacteria readily find a lodgment in it; and it is to be remembered that not only do the bacteria present in the milk at the time it is swallowed continue to decompose it in the stomach, but they continue to multiply, so that, if even a few are present in the milk when it is taken, they may within a short time multiply greatly, and produce extensive changes in the food if they find conditions favorable to their growth in the intestinal canal."

The Dakotas and their Holy Stones.—Mr. H. C. Hovey gave before the American Association a description of "Eyah Shah," or Red Rock, a sacrificial stone of the Dakotas, which is near St. Paul, Minnesota. It is a well-known custom among the Dakotas to worship the bowlders that are scattered among the hills, valleys, and prairies where they may dwell. "When a Dakota was in perplexity or distress, he would clear a spot from grass or brush, roll a bowlder upon it, streak it with paint, deck it with feathers and flowers, and then pray to it for needed help. Usually when a stone had thus served its purpose, it was no longer regarded as a sacred object, but might be disposed of in any way that suited the savage whim. But the peculiarity of the sacrificial stone now described is that from year to year and from one generation to another it was a shrine to which pilgrimages were made and where offerings were laid. Notwithstanding the significance of its name, the stone is not naturally red, but is merely an extremely hard

specimen of hornblende-biotite-granite, about five feet long and three feet wide. It is also called "Waukau," or a mystery. "The hunting-ground of the clan claiming the altar was upon the St. Croix River; and invariably before starting on an expedition they would visit Eyah Shah and leave an offering of gayly painted feathers, or a duck, or a goose, or a haunch of venison, and after a few simple ceremonies they would go on their way. But twice a year the clan would meet more formally, in order to paint the stone, which they did with vermilion, or, as some say, occasionally with the blood of their enemies which had been saved up for the purpose. When the painting was done they would trim the bowlder with feathers, flowers, and other ornaments, and dance about it before sunrise, with chants and prayers for successes from the mysterious spirit of the rock. The rock was last known to have been visited in 1862, just before the massacre, although the stripes have been renewed, possibly by the white men. "By the compass, Eyah Shah lies exactly north and south. It is located just twelve paces from the present river-bank. The north end is ornamented by a design representing the sun—a rudely drawn face surrounded by fifteen rays. These markings are interesting, because, if not actually made in their present condition by the Indians, they were evidently meant to reproduce their original work."

The Order of Children's Studies.—In a paper on this subject read before the Education Society, Mrs. Bryant says that the order of studies should depend both on the order of the development of faculty and the order of logical dependence in knowledge. Subjects become interesting to a child as his intellect develops a capacity for dealing with them; hence, the order of interest in studies for children should be taken as a clew to the natural order of studies for them. Children are interested in the superficial aspects of Nature. Nature-knowledge should be one of their first studies, developing gradually into natural science as intellect ripens and the age of reason draws near. Children are also interested in social objects so far as these appeal to their rudimentary faculties of emotion and imagination. History and literature of the elementary kind should find a place among their studies, and thus preparation may be made for a scientific study of the same subjects later on. The mother-tongue is profoundly interesting to children, and they are, to some extent, interested in foreign languages, the acquisition of which is at the most quite possible to them. Hence the study of the English and of a foreign language may take an early place in the curriculum. The increasing complexity and the increasing inwardness which characterize mental development throughout bring about at last that capacity for and impulse in search of general knowledge which distinguish the adult from the childish mind. Then the order of studies is dominated by the logical sequence of sciences.

Prehistoric Monuments in Southeastern Africa.—A feature of the region of Eastern Africa south of the Zambesi, which has hitherto escaped the attention it deserves, is the evidence that is cropping out day by day, in the shape of extensive ruins, of the existence of a prehistoric civilization and an ancient flourishing state in the country. The ruins are of such a character as to indicate the former existence, not merely of one or two cities, but of a considerable dominion. Ruins of cities have been discovered which have stood, if the difference in climate be considered, nearly as well as the most enduring monuments of Egypt, and better perhaps than those of Assyria, the wear and tear of time. In the imperfect state of our knowledge of the country, it is impossible to fix upon any particular mass of ruins and say that it was the chief city of the ancient state. The ruins of Zimbabye are of great extent, and most remarkable for the strange shapes they present as well as for their enduring structure. Walls twelve feet thick at the base, and tapering upward to a height, even now, of thirty feet, constructed wholly of small hewed blocks of granite, put together without mortar, and in which are imbedded blocks of stone eighteen and twenty feet in length, apparently to support a gallery, sufficiently testify to the ingenuity and industry of their builders. North of these, about Manica, many ruins are to be found, and no less than three hun-

dred and fifty miles west of these again masses of masonry are to be seen, like the others described in solidity and singularity of shape. No inscriptions have been discovered and verified, but a forty-years resident, a native of Portuguese India, who has married one of the queens of the country, says there are numerous inscriptions about Manica, for which his descriptions indicate a cuneiform character. Much may be said in favor of Consul O'Neill's theory, that the ruins are the remains of ancient Phœnician settlements.

"Hereditary Stature."—Mr. Galton has completed "to a well-defined resting-place" his investigations of hereditary stature, and has declared his conclusions in a kind of a general rule. The main problem which he had in view was to solve the question: given a man of known stature, and ignoring every other fact, what will be the probable height of his brothers, sons, nephews, grandchildren, etc.; what will be their average height; and what proportion of them will probably range between any two heights we may specify? From his measurements, which were made by a method that he calls "almost absurdly simple," he found that for every unit that the stature of any group of men deviates upward or downward from the level of mediocrity (five feet eight inches and a quarter), their brothers will, on the average, deviate only two thirds of a unit, their sons one third, their nephews two ninths, and their grandsons one ninth. In remote degrees of kinship, the deviation will become zero; in other words, the distant kinsmen of the group will bear no closer likeness to them than is borne by any group of the general population taken at random. The *rationale* of the regression from father to son toward the level of mediocrity is due to the fact that the child's heritage comes partly from a remote and numerous ancestry, who are, on the whole, like any other sample of the past population, and therefore mediocre, and partly only from the person of the parent. Hence the parental peculiarities are transmitted in a diluted form, and the child tends to resemble, not his parents, but an ideal ancestor who is always more mediocre than they. Every one of the many series of measurements with which Mr. Galton has dealt in his inquiry has conformed with satisfactory closeness to what is called the "law of error." He knows of scarcely anything so apt to impress the imagination as this law. "It reigns with serenity in complete self-effacement amid the wildest confusion. The huger the mob and the greater the apparent anarchy, the more perfect is its sway. Let a large sample of chaotic elements be taken and marshaled in order of their magnitudes, and then, however wildly irregular they may seem, an unsuspected and most beautiful form of regularity appears to have been present all along. Arrange the statures side by side in order of their magnitudes, and the tops of the marshaled row will form a beautifully flowing curve of invariable proportions; each man will find, as it were, a preordained niche, just at the right height to fit him, and, if the class-places and statures of any two men in the row are known, the stature that will be found at every other class-place, except toward the extreme ends, can be predicted with much precision. It will be seen, from the large values of the ratios of regression, how speedily all peculiarities that are possessed by any single individual to an exceptional extent, and which blend freely together with those of his or her spouse, tend to disappear. A breed of exceptional animals, rigorously selected and carefully isolated from admixture with others of the same race, would become shattered by even a brief period of opportunity to marry freely. It is only those breeds that blend imperfectly with others, and especially such of these as are at the same time prepotent, . . . that seem to have a chance of maintaining themselves when marriages are not rigorously controlled. . . . It is on these grounds that I hail the appearance of every new and valuable type as a fortunate and most necessary occurrence in the forward progress of evolution."

How Inventions are evolved.—Vice-President Chanul, in his address before the Mechanical Section of the American Association, considered what might be called the evolution of inventions. Nothing, he said, is more remarkable than the multitude of minds and facts which are required for the

perfecting of even a simple machine, or how little the last man may need to add to complete the invention. Facts and natural laws, known for years as curiosities, are taken up by some inventor, who fails in the attempt to render them of practical use; then a second genius takes hold, and, profiting by the mistakes of the first, produces, at great cost, a working machine. Then comes the successful man, who works out the final practical design, and, whether making or losing a fortune, yet permanently benefits mankind. This course is exemplified in the address by the relation of the growth of the steam-engine; and so with other inventions: the steamboat was being developed from 1760 to 1807; the locomotive from 1802 to 1829; the telegraph, from 1729 to 1844; the sewing-machine, with its two thousand patents, from 1790 to 1860; and the reaping-machine for seventy-five years—the last successful man adding generally but little to the work of his forerunners. The rule has been that "the basis of success lay in a thorough acquaintance with what had been done before, and in setting about improvement in a thoroughly scientific way."

Composite Photography of Handwriting.—Dr. Persifer Frazer has published a paper on "Composite Photography applied to Handwriting." The principle of the application is the same as that proposed by Mr. Galton for the production of composite portraits, to be typical of a family, a race, or a class of persons. With relation to the practical value of the application contemplated in Mr. Frazer's paper, the author says that, in examining with care a composite signature, "it at once arrests the attention that the variations are not equally distributed over the entire body of the letter, but that there are regions of each letter where variations of a particular kind are noticeable, and other regions where there are few or none. The more the manuscripts of an individual are compared the more forcibly does this fact appear, until finally one is tempted to conclude that after a handwriting is once formed it can not *naturally* exhibit deviations except within a defined variation and in certain limited areas adjacent to the separate letters. It is thus as great an assistance to an observer to study the variations as to study the ideal signature. Indeed, the variations are all-important in the matter of identification, and if there were no variations the method would be inapplicable, because an exact copy might be made by tracing." The principle was applied by Mr. Frazer in a recent case in a Philadelphia court, and he thinks, from the experience thus far gained, that "it will (at least in many cases) more surely lead to the truth than will the mere opinions of the most skillful expert."

Sesostris.—On the first day of June last, M. Maspero, in the presence of the Khedive and a number of Egyptian and European notables, unwrapped the bandages of the mummy of Rameses II—the Sesostris of the Greeks, and the Pharaoh of Moses and the Hebrew oppression—which was found about two years ago at Dayr-el-Bahari, near Thebes. The mummy was identified by the inscriptions on the lid of the sarcophagus and on the outer winding-sheet. The profile of the goddess Nut, which was painted on a linen sheet covering the front of the mummy, was "unmistakably designed after the pure and delicate profile of Seti I," the father and predecessor of Rameses. In a quarter of an hour after the unrolling was begun, the face of the monarch was revealed, as it had been laid away 3,000 years ago. "The head is long, and small in proportion to the body. The top of the skull is quite bare. On the temples there are a few sparse hairs, but at the poll the hair is quite thick, forming smooth, straight locks about five centimetres in length. White at the time of death, they have been dyed a light yellow by the spices used in embalmment. The forehead is low and narrow; the brow-ridge prominent; the eyebrows are thick and white; the eyes are small and close together; the nose is long, thin, hooked like the noses of the Bourbons, and slightly crushed at the tip by the pressure of the bandages. The temples are sunken; the cheek-bones very prominent; the ears round, standing far out from the head, and pierced, like those of a woman, for the wearing of earrings. The jawbone is massive and strong; the chin very prominent; the mouth small

but thick-lipped, and full of some kind of black paste. This paste, being partly cut away with the scissors, disclosed some much worn and very brittle teeth, which, moreover, are white and well preserved. The mustache and beard are thin. They seem to have been kept shaved during life, but were probably allowed to grow during the king's last illness; or they may have grown after death. The hairs are white, like those of the head and eyebrows, but are harsh and bristly, and from two to three millimetres in length. The skin is of earthy brown splotched with black. Finally, it may be said that the face of the mummy gives a fair idea of the face of the living king. The expression is unintellectual, perhaps slightly animal; but, even under the somewhat grotesque disguise of mummification, there is plainly to be seen an air of sovereign majesty, of resolve, and of pride. The rest of the body is as well preserved as the head; but in consequence of the reduction of the tissues its aspect is less life-like. . . . The corpse is that of an old man, but of a vigorous and robust old man. We know, indeed, that Rameses II reigned for sixty-seven years, and that he must have been nearly one hundred years old when he died." Another mummy, which had been laid in the sarcophagus of Queen Nofretari, queen of Ahmes I of the eighteenth dynasty, proved, when unbandaged, to be the mummy of Rameses III, another great king, of the twentieth dynasty. It was less well preserved than the mummy of Rameses II. The physiognomy is more delicate and more intelligent; but the height of the body is less, the shoulders are less wide, and the strength of the man was inferior. The two mummies, replaced in the glass cases, will be exhibited with their faces uncovered in the museum at Boulak.

Maternal Families.—Sir George Campbell, president, began his address to the Anthropological Section of the British Association with some observations on the races of India. He spoke particularly of the Khassyahs, a very peculiar people of the hill regions, with highly developed constitutional and elective forms of government, who were also specially interesting as exhibiting an excellent specimen of the matriarchal or matriherital system fully carried out under recognized and well-defined law among a civilized people. The result of his observation of them had been to separate in his mind the two systems of matriheritage and polyandry, and to suggest that polyandry was really only a local accident, the result of scarcity of women. Among the Khassyahs there was no polyandry, so far as he had been able to learn, though there was great facility for divorce; and heritage through the female became quite intelligible when he saw that the women did not leave the maternal home and family and join any other family, as do the Aryans. They are the stock-in-trade of the family, the queen-bees, as it were; they take to themselves husbands—only one at a time—and, if he is divorced, they may take another; but the husband is a mere outsider belonging to another family. The property of the woman goes in the woman's family, the property of the man in his own maternal family. It should be added, however, that in these maternal families, though the heritage comes through the female, the males rule. The extension of our accurate information respecting the diverse peoples of India might throw a flood of light on the social history of the human race. The speaker then proceeded to what he announced as the main object of his address—to recommend the systematic and scientific cultivation of man, which he might call homi-culture, with a view both to physical and mental qualities. It seems very sad, indeed, he said, that when so much has been done to improve and develop dogs, cattle, oysters, and cabbages, nothing whatever has been done for man, and he is left very much where he was when we have the first authentic records of him. Knowledge, education, arts, he has no doubt acquired; but there seems to be no reason to suppose that the individual man is physically or mentally a superior creature to what he was five thousand years ago. We are not sure that under very modern influences he may not retrograde. In regard to animals and plants we have very largely mastered the principles of heredity and culture, and the modes by which good qualities may be maximized and bad ones minimized. Why should not man

be similarly improved? Surely, if we only have the requisite knowledge, and, taking a practical view of life, could regulate our domestic arrangements with some degree of reason, rather than by habit, prejudice, and the foolish ideas cultivated by foolish novelists, this might be done. Probably we have enough physiological knowledge to effect a vast improvement in the pairing of individuals, if we could only apply that knowledge to make fitting marriages, instead of giving way to foolish ideas about love and the tastes of young people, whom we can hardly trust to choose their own bonnets.

The Place of Geography in School-Studies.—The burden of General Sir F. J. Goldsmid's presidential address before the Geographical Section of the British Association was, that the place which geography holds among school-studies is not that which it ought to hold if its uses were understood and appreciated. As a matter of state and public-school education, the science of geography should be elevated, not degraded. It should be placed on a par with classics, mathematics, and history, with each and all of which it has affinity. A knowledge of geography is not one of those accomplishments which will come, as it were, of themselves, or are the outcome of lightly sown seeds in the home; it will not come, like handwriting, with incidental practice, nor is it to be gained by mere traveling. After a running review of the principal geographical work of the world during the year, the speaker mentioned the east and west coasts of Africa as two regions in which geographical activity had been evinced in a remarkable degree. "It is really astonishing," he said, "to trace the changes in a map of Africa during the last quarter of a century. Large spaces that were quite blank have been filled up with conspicuous delineations of mountains, fine lines representing rivers, crossed by or connected with finer lines of affluents or feeders, with names, circles, and dots for towns or villages. Yet, as I now contemplate that map in its latest form, it seems to me that hundreds of spots visited have yet to be indicated, and that the coast lines of the Indian Ocean on the one side and the Atlantic on the other are teeming with life imported, as it were, from Europe." An adequate knowledge of geography combined with history ought to have contributed to prevent the English Government consenting to the treaty it has made, though it is still unratified, with Portugal, respecting the lower Congo. While full information respecting the history and geography of such important countries as Afghanistan, Beloochistan, and Persia, is available in books, it is nowhere to be found in the comprehensive form that would necessarily be adopted were geography honored with professorial chairs; but, in the absence of the appropriate manual, search must be made in encyclopædias, gazetteers, and volumes of history and travel.

NOTES.

THE question of the origin of the red sunsets, which still continue to appear at times, is yet a subject of discussion. The theory of their being due to volcanic dust in the air is still most in favor, but their persistency is by some regarded as a cause of objection to it. Professor Newcomb suggests in "Nature" that, in order to reach a decisive conclusion on the matter, we must have observations made in regions where the upper atmosphere is exceptionally free from vapors and other attenuated matter, and where, consequently, the advent of such matter could be detected when it could not be determined at other places. He names the Cape of Good Hope as such a region, and hopes that observers there will give special attention to the investigation.

PROFESSOR F. W. PUTNAM gave, in the American Association, a *résumé* of results from his explorations of burial-places, mounds, and earthworks, during the past twenty years, in various parts of the United States. They go to show that successive peoples have inhabited the several regions of the country, and that the mounds were made by different people at different times, as evidenced by their structure and contents.

PROFESSOR BOYD DAWKINS said, in a British Association paper on the exploration of Gop Cairn, commonly known as Queen Boadicea's tomb, and of the cave at St. Asaph, that the human remains found in the cave threw great light on the ethnology of the district in the bronze age, and proved that in the Neolithic age the population of that part of Wales was of the Iberian type. All the skulls were of this type save one, and that possessed all the characteristics usually found in a round-headed Celt of the bronze age. These appeared to indicate that fusion

of the two races which has been going on ever since, and by which the Iberian type is at the present time being slowly obliterated.

JOSEPH JASTROW communicated to the American Association an account of some experiments with ants, from which it results that, having regard to the difference in size, these little insects walk from seven to fourteen times as rapidly as man. Other experiments indicated a sensitiveness to odors. When brushes were dipped in various substances, the ants invariably took notice of those which had been dipped in lavender, and mostly noticed those which had been dipped in cloves or mint, but were indifferent to brushes which had been dipped in distilled water. Lavender appears to be extremely disagreeable, and even deadly, to them.

PERTINENTLY to a controversy between German and Scandinavian archæologists as to priority in the classification of the prehistoric ages—stone, bronze, and iron—Professor Virchow contends that two Germans, Lish and Danneil, discovered the three ages simultaneously with the Dane Thomsen. In support of his position, he quotes a memoir by Lish, which was published in 1837, but was in large part printed in 1836, before Thomsen's work appeared, and when it was wholly unknown to him, expounding a similar theory. In 1835, Lish had actually arranged prehistoric objects in the museum in Mecklenburg, according to the three ages. Danneil's share in the discovery does not appear so pronounced.

IT is usually believed that bats hibernate at home, in a dormant condition in caves, hollow trees, and other places of retreat. But according to Dr. C. H. Merriman's observations, as he related them in the American Association, the evidence is complete that the hoary bat and the silver-haired bat emigrate. The hoary bat belongs to the Canadian fauna, but in fall and winter occurs at places far to the southward of its breeding-range. The silver-haired bat occurs regularly in spring and fall at a lonely rock about twenty miles off the coast of Maine. No bats breed at this place, and the nearest island is fourteen miles distant.

A REMARKABLE illustration of the power of lightning has been observed at Lōiten, Norway, where a fir-tree eighty feet in height was struck, with such effect, that it was cut in two, and the upper part, which was about sixty feet in length, was thrown to a distance of several yards. The surface of the detached part is as smooth as if it had been cut with a saw, while the stump is jagged, charred, and split to the root. The ground around the tree is furrowed in all directions.

M. WALTHER has made some observations in the Mediterranean Sea of the manner in which chalk is formed by sea-weeds. He particularly studied the *Lithotamnia* of the Bay of Naples, which grow at depths of from one hundred to three hundred feet, a class of algæ remarkably poor in organic matter, but rich in mineral constituents, among which carbonate of lime is preponderant. They grow to be about as large as the hand, and then die without suffering change of form by decomposition. Living plants attach themselves to dead ones, and thus extensive deposits are formed. Beds of pure, uncrystallized chalk remain after the gradual disappearance of the organic matter, the vacancies left by which are gradually filled with calcareous substance. Beds of chalk thus formed may, under some conditions, attain great thickness.

M. PASTEUR recently reported concerning 1,656 cases which he had treated of persons bitten by rabid animals. Of 1,009 French cases, 3 had died; of 182 Russians, 11, 8 of whom had been bitten by wolves, not by dogs; of 20 Roumanians, 1; of 445 from other countries, including 18 from America, none. The total number of deaths was, therefore, fifteen, or less than one in a hundred.

THE committee of the British Association on Antarctic research has reported that, in view of the great increase in facilities for prosecuting work of that kind consequent upon the development of steam navigation, it desires to secure a full discussion of plans for the purpose of giving more definiteness to the objects sought to be obtained, and to the best means of obtaining them.

SEA-TROUT have been artificially spawned with great success at the South Kensington aquarium, even from fish which had been kept in captivity for three years and had never visited the sea. The different species of the *Salmonidæ* living in the tank are found to pair quite readily with one another. Fish in captivity yield their ova much later than they do when in a wild state; but, of every thirty subjected to artificial existence, only one is, on the average, barren.

A COMMITTEE has been formed in Paris for the organization of a floating exhibition for the purpose of bringing the products of French industries within the view of the people of other countries. The Sarthe, a vessel of 3,900 tons, has been furnished to the enterprise by the Minister of Marine. The exhibition will fill about 1,600 cubic metres of glass cases and counters; and 400 square metres will be given to machinery. The first voyage of the exhibition will be to the coasts of Central and South America.

It was reported recently, in the Royal Society of Tasmania, that a Mr. Vimpany had captured a black snake four feet three inches long, in which one hundred and nine young ones were found. The greatest number said to have been before taken from a single snake was seventy.

M. Lewin has reported to the Berlin Medical Society his observation of an affection that seems to be peculiar to workers in silver. It appears in the form of round or oval bluish spots on the skin, which in extreme cases may be as large as a nickel five-cent piece, generally on the back of the left hand. Workmen in metals who do not use silver are free from it. The manner in which the spots are produced is not clear, for experiments with the direct application of silver in various forms have failed to generate them. The silver probably falls upon some scratch—for the spots are usually developed where there has been a lesion—in a solution, and afterward undergoes some chemical change by the action of the bodily fluids which induces the peculiar color.

Mr. W. H. Preece described, in the British Association, how he had extracted a piece of needle from his daughter's hand by the aid of a suspended magnetized needle. The needle was strongly deflected, and invariably, when the hand was moved about, pointed to one position, which was marked with a spot of ink. The needle was afterward extracted by cutting at this spot.

Pertinently to the question whether man in the palæolithic age was acquainted with the potter's art, M. Martel reports that he found last year in the cave of Nabrigas, in immediate contact with the remains of specimens of the cave-bear, nine fragments of human skulls, and a piece of rough pottery, not turned in a lathe. In connection with this discovery he adduces the fact that, fifty years ago, M. Joly found in this same cave a fragment of a large vessel in contact with the skull of a fossil bear. There is no trace of any disturbance, no other neolithic objects are found, and the skull is in its natural position; therefore he is persuaded that the question should be answered in the affirmative.

Tommasi-Crudelli and Klebs published the account of the discovery of the schizomycete (*bacillus malariæ*) as the causal agent of malarious fevers, in 1879. Marchiafava and Celli have announced, as the result of their researches on an individual affected with malaria, that within the red-blood globules are constantly found plasmatic bodies endowed with lively amœboid movements, in which the hæmoglobine is transformed into melanine; and in a further memoir they suggest that these plasmatic bodies may be the living organisms that produce malaria. Thus they confirm in substance Tommasi-Crudelli's opinion that a living organism is the cause of malaria, but they regard its form as differing from a schizomycete.

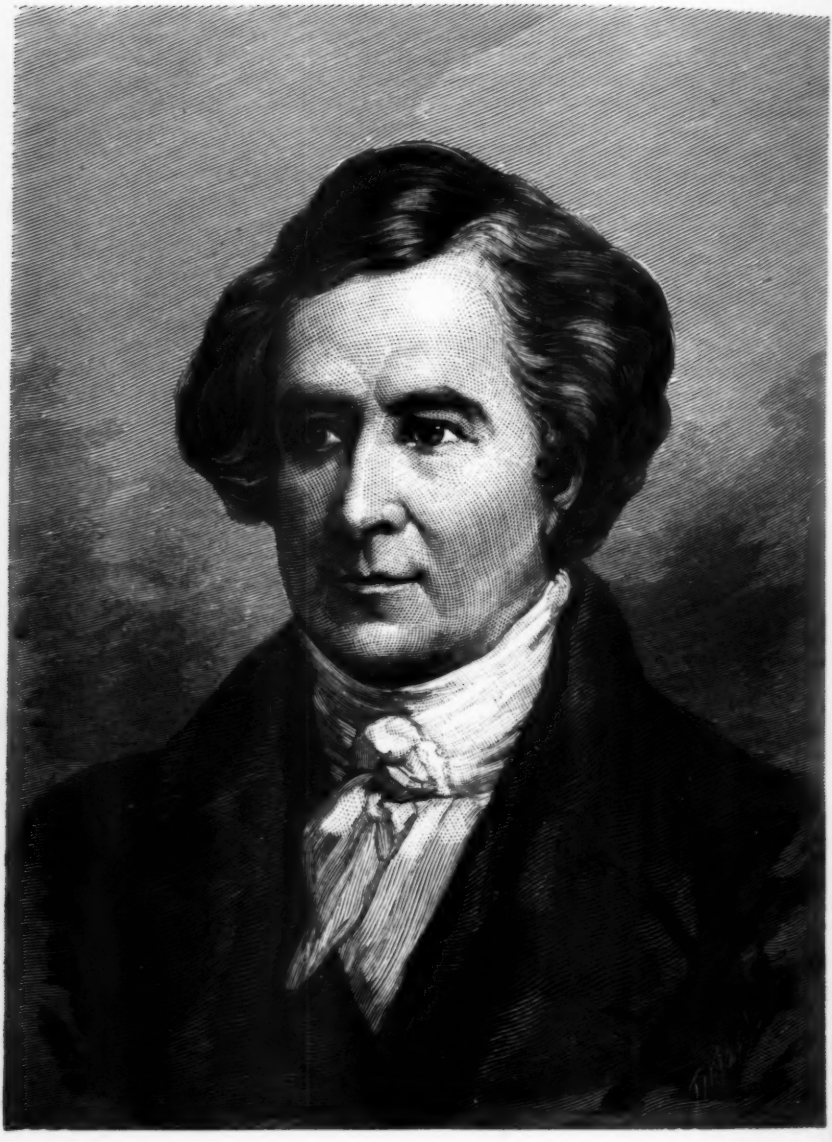
Professor Windle has announced to the British Association, as conclusions from his researches on the subject, that man's original dentition included six incisors in either jaw; that two from each jaw have gradually disappeared; that this loss is due to the contraction of the anterior part of the palate; that this process of contraction will probably go on and result in the loss of two further incisors; and that the conical shape of many of the supernumerary teeth indicates a reversion to the primitive type of tooth.

The operation of compulsory vaccination was suspended in Zürich, Switzerland, in obedience to popular clamor, in 1883. The deaths from small-pox per 1,000 total deaths for the two previous years and that year had been, in 1881, 7; in 1882, 0; in 1883, 8. They rose, after compulsion had ceased to be used, in 1884, to 11·15; in 1885, to 52, and in the first eight months of 1886, to 85, per 1,000.

Mr. James W. Wells relates that while exploring the stream connections between the head-waters of the Brazilian Rios Tocantins and San Francisco, in 1875, the natives, unaccustomed to the sight of white men, attached a mystery to the presence and personality of one who was neither a trader, planter, priest, nor soldier. They finally decided that he was anti-Christ entering the country with the object of making slaves of the people and heathenizing them; and they were afterward discovered most fervently offering up prayers for deliverance from the machinations of the evil-one.

A very severe earthquake occurred in Greece, the Ionian Islands, and other lands of the Mediterranean Sea, on the 29th of August. In the southwestern Peloponnesus, four considerable towns and a large number of prosperous villages, with about sixty thousand houses, were destroyed, and hundreds of persons were killed. An eruption of Vesuvius was reported at about the same time. The close approach to coincidence in time—making allowance for the distance—of this earthquake with that at Charleston is noticeable; but it is not supposed that a coincidence exists in any other respect.

Artesian wells are of great antiquity in China. Abbé Huc describes the method in which they were bored. It is by tubulation, and drilling with a rammer regulated by a rattan cord—a rude suggestion of the more perfect apparatus which is now used among us.



FRANÇOIS ARAGO.